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Causes and Prevention of Static Markings on Motion-Picture Film

By W. I. KISNER

Streaks, blotches or other types of markings seen on processed film can often be traced to discharges of static electricity although the patterns produced are not always easily recognized as being due to this cause. Examples are shown of various types of markings which originate in different ways. Some suggested procedures for minimizing the occurrence of these markings are outlined.

NOTHING SEEMS more exasperating to the conscientious motion-picture technician than to discover on viewing his processed films, black or white spots, blotches, streaks or other markings which render his films valueless and nullify all of the efforts he has put forth in long hours of painstaking work. There are, of course, many types of such markings and a great variety of causes for these defects. Each occurrence demands a thorough investigation to locate the source of the trouble and adoption of procedures which will prevent its happening in the future.

Not infrequently, black or other types* of markings may be traced to the effects of static electricity, although this cause may not be easily recognized because of the different types of markings and the occasional erratic behavior of the discharge. In the following paragraphs, some information is given which is intended as an aid in identifying markings caused by static discharges, in locating the source of the difficulty, and in choosing certain precautionary measures in the handling of film which will minimize the possibility of having such discharges occur.

A contribution submitted June 11, 1958, by W. I. Kisner, Motion Picture Film Dept., Eastman Kodak Co., 343 State St., Rochester 4, N.Y., in response to a request by the Tutorial Subcommittee of the SMPTE Papers Committee.

*As noted in a later paragraph, markings may be lighter than the surround area on black-and-white reversal films and colored on color films.

The Nature of Static Electricity†

Practically everyone is familiar with certain manifestations of static electricity encountered in the course of everyday life. We glide across a heavy carpet and accidentally touch a metal object and suddenly a spark occurs. Or, on a dry day, we may perform the simple operation of combing our hair and hear the crackling sounds of static discharges emanate from the comb. Somewhat less familiar perhaps is the glow discharge seen when a strip of adhesive tape is pulled quickly from its parent roll in a darkened room.

These and other phenomena can be most simply explained by the statement that all matter is fundamentally electrical in nature and contains countless billions of infinitesimally small, electrically charged particles, some of which we have come to know as *electrons*. Under ordinary conditions, they appear to be only a figment of the imagination or a convenient tool for the scientist and forever blocked from view within their physical boundaries. But, under certain other circumstances, we come to know them by their deeds, especially when they are transferred from one object to another.

When, by some means, an object is robbed of some of its electrons or acquires additional ones, we say it is in a "charged" condition. Electrons are negatively charged particles; consequently, if an object loses some of its electrons, it becomes less negative or more aptly, "positively charged." On the other hand, an object which has acquired additional electrons is said to be "negatively charged." Such charged objects always seek to return to their original neutral state or "ground potential" as it is commonly called. They do this by virtue of the transfer of electrons to or from other objects, the air or the ground, sometimes quite without event but at other times with some violence.

The most common manner in which materials become charged is through friction. If a nonconductor of electricity such as glass, hard rubber, or a synthetic plastic material is rubbed with an insulated dry substance (which itself may even be a conductor), the surface of the nonconductor becomes charged. The greater the amount of friction between the two materials, the greater will be the charge produced. Due to the poor conductivity of the material being rubbed, the charge may build up and remain for some time in local areas. Over a period of time, of course, the charge will disappear because of leakage currents over the surface of the material. However, if the charge is sufficiently great, the air in the immediate vicinity of the surface may become "ionized" by the strong electrical field. When this occurs, a "corona" discharge is formed. If some object is near the charged material, a more disruptive type of discharge may take place between the material and the object. In either case, energy is dissipated in the form of both light and heat.

When a good conductor of electricity such as a metal is insulated and subjected

†Textbooks refer to this branch of Physics as "electrostatics"; however, terms such as "static electricity" or "static" have come into common usage.

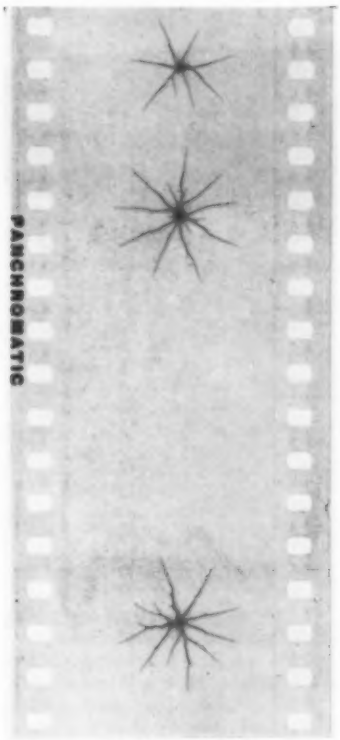

Fig. 1. Markings caused by discharges between a small nearby object and a negatively charged film.

to friction, an electrical charge is also generated. However, the ease of transfer of electrons through the metal allows the charge to distribute itself quickly and more or less evenly over the surface. If the metal is then grounded by connecting it to the earth, the entire charge flows away. Thus it is impossible to maintain sufficient charge on a good conductor to produce a disruptive spark if it is properly grounded.‡

Another way in which a material can become charged is by the intimate contact of its surface with a dissimilar surface; after subsequent separation, the material may have acquired a charge. The extent of the charge depends upon the particular materials involved, their intimacy of contact, their electrical conductivities, and the conditions of separation. Charges are frequently produced on materials of low conductivity which have a surface coating of some type applied to one side and are then cut and stacked in piles or wound into rolls. Sheets of coated paper piled in intimate contact, tightly wound rolls of coated paper, adhesive tape, and emulsion-coated motion-picture film base are good examples. Two dissimilar surfaces, when in contact, will inherently charge to slightly different levels. Because of the

‡The best "ground" is usually obtained by connection to a water pipe.

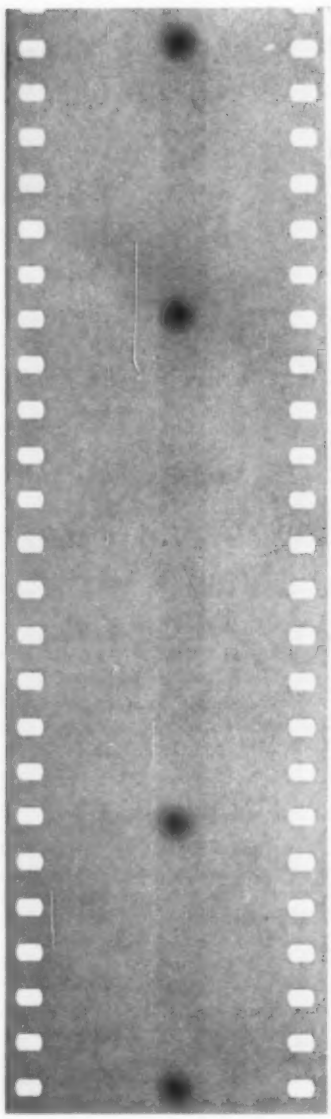

Fig. 2. Markings caused by discharges between a small nearby object and a positively charged film.

difference in charge levels, a small potential difference exists between the two surfaces. Upon separation, however, because of the large decrease in electrical capacity, the potential differences between the surfaces may be increased by several thousand times. Rapid separation of such surfaces can easily lead to a spark discharge. Frequently the spark discharge may take the form of multitudinous tiny discharges extending all along the line of separation. Under these conditions, a continuous glow discharge is seen as in the case where adhesive tape is pulled from the roll.

Any factor which tends to cause more intimate contact of the surfaces in question will make the conditions more favor-

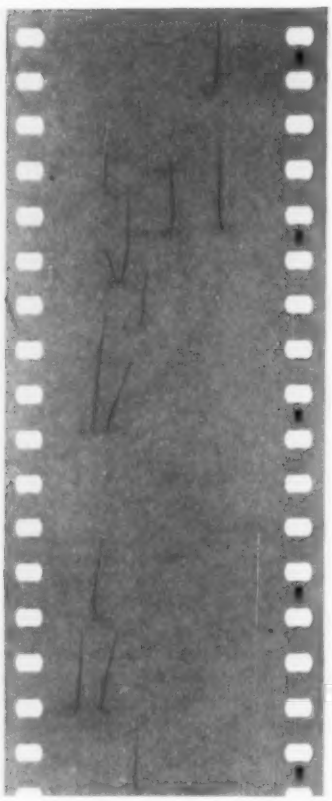

Fig. 3. Markings caused by discharges between a roller and a negatively charged film.

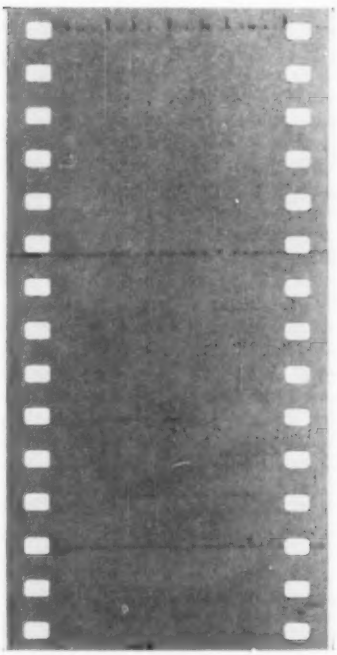

Fig. 4. Markings caused by discharges between a roller and a positively charged film.

Fig. 5. Markings from discharges in unwinding from a stock roll with the leaving strip of film having a negative charge.

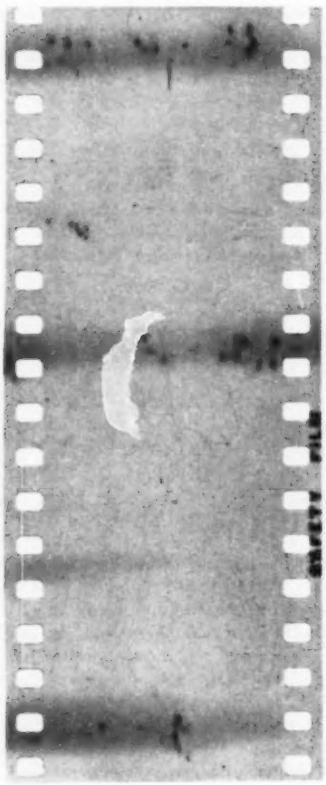

Fig. 6. "Bar static" markings from discharges in unwinding from a stock roll of film having a positive charge.

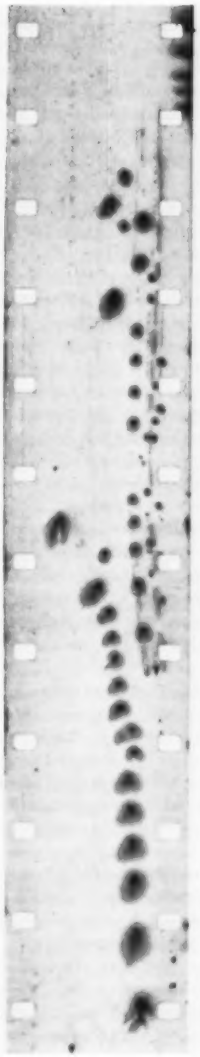

Fig. 7. Markings caused by discharges generated by rubbing 16mm film with hands.

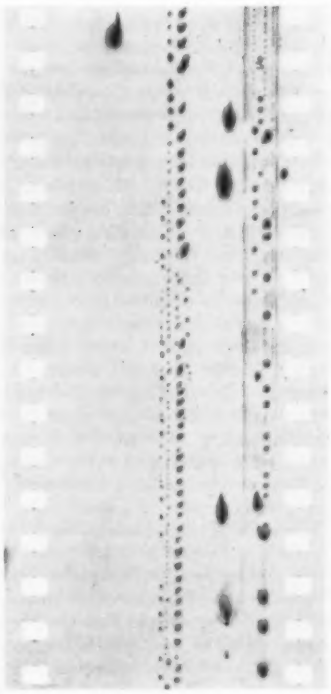

Fig. 8. Markings caused by discharges generated by rubbing 35mm film with hands.

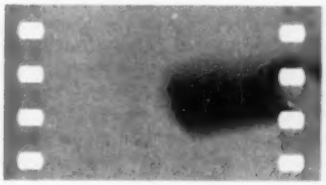

Fig. 9. Type of markings caused by discharges occurring in unwinding of roll with excessive moisture — often referred to as "moisture static."

able for producing high potentials and, in turn, increase the chances for spark discharges to occur. For example, if the material is allowed to come to equilibrium with room air having a very high moisture content, the surfaces become tacky and tend to adhere better. Also, if wound rolls of material are subjected to higher than normal temperatures for a few hours, thermal expansion increases the interlayer pressure and may increase the tackiness of the surface; this will result in greater adhesion during unwinding even if such rolls have been reconditioned to lower temperatures after the high-temperature storage period.

Static Discharges on Motion-Picture Film

Since the earliest days of motion-picture photography, occurrences of spark discharges and resultant markings on the processed film have been known.[§] Such discharges have been traced on different occasions to the camera, to the printer, to rewinding operations, to the processing machine loading elevator and elsewhere. It is also conceivable that charges could be accumulated on the operator due to friction of clothing against parts of the machine or by reason of his walking across a floor in shoes having insulating soles of gum rubber or Neolite. Discharges might then occur from his hands on touching the film. In other words, wherever film may be handled, and particularly where it may be subjected to friction or rapidly un-

§J. I. Crabtree and C. E. Ives, "Static markings on motion-picture films; their nature, cause and methods of prevention," *Trans. SMPE, 21:* 67–84, May 1925. (Revised April 1929.)

wound from tight rolls, the possibility of a static discharge exists.

Sometimes the markings occur at regular intervals on the film, thus pointing to some moving element in a camera or printer having a similar periodicity and which provides a target to which the discharge can occur. More often, the occurrence is erratic and unpredictable. If friction on the film takes place in a local area, the discharge usually takes place in the same vicinity. However, if the friction is evenly distributed over the film surface, the discharges occur at irregular intervals and at no particular location except as noted above. Very frequently, the markings extend inward from the perforations and edges of the film, indicating that friction is being caused by a sprocket or roller which is not free to turn or by a build-up of a hard gelatin deposit on a guide rail.

It was formerly considered somewhat questionable whether static markings were caused as a direct effect of the spark on the silver halide grains of the emulsion or whether they resulted from the photographic effect of the light rays emitted by the discharge. It was also questionable whether the sensitivity or speed of the emulsion played a very important part on the intensity of the static markings for a given discharge. This was particularly true of the slow-speed camera films of former years. However, it is known now that static markings result primarily from the action of the light rays on the emulsion and that higher speed films are more sensitive to the light from a given static discharge than are the slower materials just as they are more sensitive to light upon exposure in the camera.

Static markings on black-and-white motion-picture negative film are almost always black and print as white markings on the positive print. On black-and-white reversal films, they appear lighter, in general, than surrounding areas. On color films, the markings are usually colored, their hue depending on what layers of the film have been affected. In all of the illustrations shown in this paper, the markings are black and are representative of the actual appearance of such markings on negative film. The patterns shown would be similar for the case of reversal film but light instead of dark.

The more familiar pattern of static markings as pictured in a number of photographic textbooks is the branch or tree-trunk structure typical of a rather violent discharge from a negatively charged film as shown in Figs. 1, 3 and 5. Such patterns are readily identified by most workers as caused by a static discharge; however, there are other types of markings which are less easily identified. Various descriptive terms such as "bar," "spot," "blotch," "pearl" or "bead," etc., have been applied to these less familiar patterns. Some examples are shown in Figs. 2, 4, 6, 7, 8 and 9.

The pattern of the static markings depends on whether the film is positively or negatively charged as shown by the illustrations. The particular type of charge is dependent upon the composition of the support, the nature of the emulsion or backing application, and the type of material which contacts the film. The character of the mark is altered when the discharge takes place on the base side of the film since, in this case, the exposure is made through the film support. Markings which extend across the film, so-called "bar static," as illustrated in Fig. 6, are usually caused by a discharge at the line of separation of the film during unwinding of a tight roll. High tension during winding operations leads to such a tight roll where the convolutions are in intimate contact. Rapid unwinding of the roll increases the severity of the discharge.

Spot static usually results when a discharge takes place in a direction perpendicular to the film. Protruding sharp points or burrs on any parts of the equipment and located near a charged area of the film may often invite such discharges to take place.

Blotchy markings of the type shown in Fig. 9 may be produced where irregular contact of the film with some external surface or with an adjacent convolution is encountered. Film having a high moisture content is especially prone to produce such markings when being unwound from the roll, since the moisture encourages more intimate contact of the surfaces as explained earlier. This is sometimes referred to as "moisture static."

The so-called "bead" or "pearl" type static, a continuous row of small static marks, is usually caused by the machine operator rubbing the film with his hands or gloves. Examples of this type are shown in Figs. 7 and 8.

Prevention of Static Discharges During Film Manufacture

No one is more acutely aware of the causes and necessity for prevention of static discharges on photographic materials than the film manufacturer. At every stage of production of sensitized materials, wherever the film may be handled, whether by machine or by an operator, the utmost precautions are taken to see that static discharges do not occur. Constant attention is paid to every machine to see that it is maintained in such condition as to assure that no excessive friction is applied anywhere to the film. All machines are grounded to allow any charges which may build up on the machine to be dissipated immediately.

The humidity conditions of the air are also maintained at that level which provides the optimum moisture content of the film. It is important to increase the moisture content of the film and its electrical conductivity in order to avoid the excessive charge build-up observed with very dry film but at the same time, to provide a level of moisture content low enough to avoid moisture static and deleterious sensitometric effects on the film. Operators are carefully instructed in the facts pertaining to static discharges and in the safest methods for handling the film. Finally, elaborate sampling and testing throughout each stage of manufacture and of the finished product is carried out in order to detect any possible markings from static or other causes.

Over the years, many advances have been made in film manufacture to provide better products for the user. Not the least of these improvements is the great increase in speed of photographic materials over that of films of former years. As mentioned earlier, the higher speed films, both negative and reversal types, are more susceptible to the effects of static electricity just as they are also more sensitive to light. This means that greater care must be exercised in the handling of these materials.

With the improvements in film properties, efforts have also been directed toward incorporation of materials in coating and toward new methods of manufacture which would minimize the static propensity of the film without undue sacrifice of other desirable properties. Extensive research is continuing, aimed toward production of films having lower static propensity. This will be of benefit to both the manufacturer and the user.

Some Recommendations for Prevention of Static Discharges and Suggestions for Location of Sources of Trouble

The user of motion-picture film products is also vitally interested in the creation of a final product which is as perfect as possible in every respect. This means that measures must be adopted in his handling procedures to assure that no marks of any kind are placed on the film either before or after processing. In handling of raw stock, he must exercise virtually every precaution which the manufacturer takes to avoid trouble. Static discharges are an ever-present threat, demanding constant vigilance on the part of anyone engaged in the handling of the material.

In the light of the foregoing discussion, the following recommendations should prove helpful in both the prevention of static markings and in detection of sources of trouble if it does occur, whether in the camera, printer, loading elevator, rewinding and inspection operations, or elsewhere.

(1) Motion-picture raw stock should not be handled any more than is ab-

solutely necessary. Where circumstances demand that film be handled by the hands, as during inspection rewinding of negative film prior to processing, careful checks should be made to insure that such handling is not introducing static marks. Also, care should be taken to see that the hands contact a minimum area of the film. If handling of the film proves to be a source of static trouble, the use of gloves treated with Tamol solution is recommended.‖

(2) Every point where film is handled, whether by machine or by an operator, should be regularly inspected for possible sources of friction or other causes which might lead to static discharges. Operators should be instructed carefully in the proper handling of the material and urged to report at once any malfunctioning of machines which might cause trouble.

(3) All moving parts of machines such as cameras, printers, rewinds, film elevators, etc., which may be used with motion-picture raw stock should be regularly inspected to be sure that the parts are turning freely at all times. This includes sprockets, idler rollers, guide rollers, registration pins, intermittent movement devices, etc.

(4) All guide rails, channels, flanges, etc., which the film may slide over or through should be inspected for correct alignment and for possible accumulation of emulsion or gelatin deposits or other abrasive particles which can cause friction.

(5) All machine surfaces located near the film path should be kept clean and free from any burrs or sharp points which might invite a spark discharge.

(6) The main bodies of machines, including rewinds, should be grounded wherever possible to allow any charges which may accumulate on the machine to be dissipated rapidly.

(7) The room air conditions should be adjusted for the proper relative humidity (RH). Both high and low relative humidities are to be avoided. An excessively high RH fosters the production of moisture static, whereas a very low RH lowers the moisture content of the film and decreases its ability to conduct the charge away. For films which do not have a removable jet antihalation backing, between 55 and 65% RH is satisfactory. Such films are packaged at the factory at 60% RH. For films having the jet backing, 45 to 55% RH is recommended since the backing is especially controlled to provide good conductivity under these conditions. Such films are packaged at the factory at 50% RH. The relative humidity of the air should be checked regularly with a sling psychrometer or other humidity gauge.

(8) Wherever the raw stock is unwound from the roll, it should be done as slowly as possible and without excessive tension. During the operation, close observation should be made to see if there are any spark discharges or glow discharges at the line of separation from the roll or elsewhere. Operators should be urged to report any such occurrences at once to their supervisors.

(9) If, for some reason, raw stock has been allowed to come to equilibrium with a relative humidity lower than 55% the conductivity of the emulsion is reduced and accumulated charges cannot leak away as rapidly. This increases the hazard of creating static charges since the normal gray negative support is practically a perfect insulator and the only conductivity the film may have is provided by the emulsion; the emulsion conductivity, in turn, depends upon the amount of moisture it contains. With such film, it is of paramount importance to observe all precautions in controlling the humidity of the air in which the film is handled. For films with jet antihalation backing, the conductivity of the latter is high and is nearly independent of the moisture content of the film. This additional safeguard provides some leeway in moisture content. However, since charges on the emulsion are potentially more dangerous, it is important to keep the raw stock in equilibrium with a sufficiently high humidity that emulsion conductivity is maintained at reasonable levels. Relative humidities lower than 45% are not recommended.

For excessively dry raw stock, it would be helpful, if feasible, to recondition the film to the proper relative humidity. This cannot be done effectively, however, when the raw stock is wound in a roll because of the slow transfer of moisture through the roll. Such reconditioning must be done by unwinding the film very slowly from the roll and allowing it to pass through a conditioning chamber of the proper relative humidity. At every stage of the conditioning operation, extreme caution must be used lest static markings are introduced as a result of additional handling of the film. As noted in (7) between 55 and 65% RH is recommended for films which do not have a removable jet backing, whereas for films which do have this backing, as low as 50% RH may be used. When films are packaged by the manufacturer they are in equilibrium with the optimum relative humidity. It is desirable, therefore, when at all possible, to keep the film sealed in its original taped can up to the actual time of use.

(10) The subjection of raw stock to higher than normal temperatures for a period of time, even for a few hours, prior to unwinding, can cause the convolutions to stick together more strongly. Even subsequent cooling of the roll does not help this condition. This greater contact of the surfaces can lead to severe static markings when the roll is unwound.

(11) Handling of film at lower than normal temperatures also increases the likelihood for static. This is partly due to the fact that the emulsion loses conductivity at low temperatures. In addition, since the film becomes less flexible when cold, the friction of the film against the entering and leaving edges of the camera gate may be increased greatly. The only solution to this problem is to provide a heated blimp for the camera, especially when the temperature is very low.

(12) In the design of equipment to be used for any operation involving raw stock, all mechanical parts should be made of conducting materials and grounded. This allows any charges accumulating on the machine to be carried to the ground.

(13) It must be remembered that static markings are mainly the result of exposure of the emulsion by the light emitted by the discharge. The higher the speed of the material being handled, the greater danger there will be of static markings. Greater care must therefore be exercised in handling of the higher speed films.

‖Cotton gloves treated with Tamol N solution. This chemical is available from Rohm and Haas Company, Philadelphia 5, Pa. The gloves should be well-laundered and then rinsed in a 10% Tamol N solution and drip-dried.

Photographic Duplication of Variable-Area Sound Recordings

By J. F. FINKLE

The factors influencing the sound-recording quality of prints made from duplicate negatives were investigated. Two photographic materials of different sensitometric characteristics were found to be suitable for use as master positives and duplicate negatives. No one set of density conditions on the duplicates produced optimal quality for all of the sound-recording characteristics simultaneously. It was found that a compromise resulting in near-optimal sound quality measured by each test can be made with some latitude in master positive–duplicate negative density.

IT IS SOMETIMES NECESSARY to prepare a duplicate sound negative photographically rather than by re-recording. This requires the preparation of a master positive from which the duplicate negative can be made. It is the purpose of this paper to show the sound-recording quality of the final print as a function of the densities at which the master positives and duplicate negatives are made. It is beyond the scope of this paper to recommend specific operating conditions since these will vary with the particular type of photographic material, recording and print equipment, and processing conditions.

The aim of the system of sound printing from duplicate negatives is to produce a release print which, in terms of sound quality, is most like a print made directly from the original photographic sound-negative. The data given here may be used to compare the sound-recording quality of prints made from original negatives with that of prints made from photographic duplicates of the original negatives. The sound-quality comparison is made on the basis of cross-modulation distortion, signal-to-noise ratio, output volume levels, frequency-response characteristic and amplitude modulation.

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Outline of Test Procedures

Table I lists the operating conditions used for the sound-recording work.

The *cross-modulation test* data were obtained with conventional techniques. The output of a 400-c (cycles per second) reference signal was compared with the 400-c distortion component of a 9500-c signal amplitude-modulated at a 400-c rate.

Signal-to-noise ratio data were taken in two different ways. In each case, the measurement was made through a restricted frequency range of 500 c through 8000 c. In one method, the output volume level of the print of a 1000-c signal was related to the output level of the print of an unbiased, unmodulated track of the same density. This is called "signal-to-noise ratio, in the absence of modulation." In the other method, the 1000-c print output level was compared with the output of the print of the 10,000-c section. Since the 10,000-c signal was not passed by the 8000-c low-pass filter, the output level measured in this manner is the unmodulated noise level plus a noise component arising from granularity at the edge of the high-frequency track.

The *frequency-response characteristic* was determined by comparing the relative output volume levels, measured in decibels, of a 1000-c and a 10,000-c signal. The measuring system was compensated for reproducer losses. The

Table I. Operating Conditions.

Photographic materials:	Eastman Fine Grain Sound Recording Film, Type 5372 Eastman Fine Grain Release Positive Film, Type 5302
Soundtrack:	Variable-area duplex
Negative exposure:	Unfiltered tungsten radiation
Print exposure:	Unfiltered tungsten radiation
Printer:	Modified Bell & Howell Model D
Development of Type 5372 Film:	Positive-type developer, 7 min at 70 F
Development of Type 5302 Film:	Positive-type developer, 3¼ min at 70 F
Densitometry:	"Blue-filter" densities measured on Type 5372 Film "Visual" densities measured on Type 5302 Film All densities shown are total densities

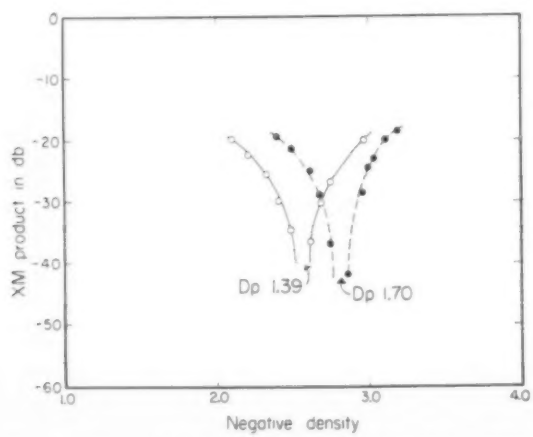

Fig. 1. Cross-modulation distortion vs. negative density, Type 5372 Film printed on Type 5302 Film.

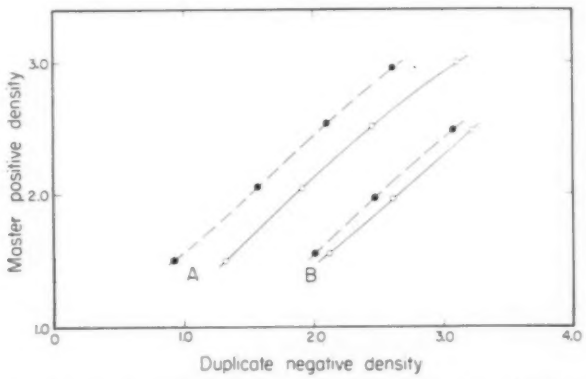

Fig. 2. Optimal master positive and duplicate negative densities for printing to a normal print density:

Original Negative	*Final Print*	*Keys*
5372 D_N 2.50	5302 D_p 1.35	○
5372 D_N 2.86	5302 D_p 1.73	●

(A) Master positive: Type 5372; duplicate negative: Type 5372.
(B) Master positive: Type 5302; duplicate negative: Type 5372.

1000-c and the 10,000-c sections were recorded at equal amplitudes of track modulation on the original negative. Amplitude modulation was measured by analyzing the 10,000-c section of each print with an intermodulation analyzer.

Discussion of Data

Original negatives of two different densities were used to represent the negative density conditions frequently used for the products tested. The data for direct cross-modulation test prints of the two original negatives are shown plotted in Fig. 1.

Throughout the tests, the arbitrary requirement was made that the duplicate negatives should be printed to the same optimal print densities, based on the cross-modulation test, as the original negatives. The loci of the optimal density data for cross-modulation tests made on prints prepared from duplicate negatives on Eastman Fine Grain Sound Recording Film, Type 5372, from master positives on Type 5372 or Eastman Fine Grain Release Positive Film, Type 5302, are summarized by Fig. 2 and tabulated in Table II. These data indicate that it is possible to prepare, at a wide range of density combinations, both master positives and duplicate negatives which are optimal for printing to the same print densities as the original negatives.

Type 5302 Film was tested for use as both master positive and duplicate negative material. These cross-modulation test data are listed in Table II. The cross-modulation and other sound-recording test data listed for the duplicating system using Type 5302 Film for both master positive and duplicate negative were not prepared at a range of density conditions. These data were included to show that the system is feasible rather than to indicate the best operating condition.

A comparison of the duplicating systems in terms of optimal duplicate negative density latitude for making prints with less than −32.5-db cross-modulation distortion shows that the system using Type 5372 Film for both master positive and duplicate negative has the greatest density latitude. The system using Type 5372 Film for duplicate negatives with master positives on Type 5302 Film had less density latitude; the system using Type 5302 Film for both master positive and duplicate negative had the least density latitude.

The signal-to-noise ratio measurements, listed in Table II, made both in the presence and in the absence of modulation, vary significantly at the master positive–duplicate negative density conditions which were selected as being optimal for the cross-modulation test. Over the range of master positive–duplicate negative density combinations tested here, the highest signal-to-noise ratio was associated with the highest density combinations. A satisfactory signal-to-noise ratio was found at the density used to test the duplicating system having both master positive and duplicate negative on Type 5302 Film.

The output-volume data measured from the 1000-c sections of each print and the frequency-response data which show the difference in output level between 1000-c and 10,000-c sections are also listed in Table II. In some cases, the highest output-volume level at 1000 c and the best indicated frequency-response characteristic do not occur at the same master positive–duplicate negative density conditions. However, a density compromise can be made in each duplicating system without much sacrifice in output-volume level or frequency response.

The amplitude-modulation components in prints of duplicate negatives are

Table II. Summary of Sound-Recording Test Data.

	Experimental conditions			Experimental Results				
				Signal-to-noise ratio		Frequency response		
Use of film	Eastman Film Type	Optimal density by XM test	At IIb gamma	Absence of modulation*	Presence of modulation†	Print output volume levels, (db) at 10,000 c relative to 1,000 c	1,000-c output volume levels (db)‡	Optimal duplicate negative density latitude§
A. Direct Print of Original Negative								
Original negative	5372	2.48	3.58	54.7	46.7	−5.7	−5.5	0.18
Direct print	5302	1.34	2.62					
Original negative	5372	2.79	3.42	53.3	46.0	−6.5	−5.9	0.18
Direct print	5302	1.80	2.60					
B. Prints of Duplicate Negatives, Original Negative: 5372, D_N 2.48								
Final Print: 5302, D_p 1.39								
Master positive	5372	1.50	3.28	42.4	37.9	−10.6	−7.8	0.26
Duplicate negative	5372	1.34	3.22					
Master positive	5372	2.04	3.28	51.1	41.3	−10.1	−5.8	0.25
Duplicate negative	5372	1.92	3.22					
Master positive	5372	2.51	3.28	54.2	42.2	−10.3	−5.4	0.24
Duplicate negative	5372	2.45	3.22					
Master positive	5372	3.00	3.28	54.7	43.1	−11.0	−5.4	—
Duplicate negative	5372	3.00	3.22					
Final Print: 5302, D_p 1.33								
Master positive	5302	1.55	2.58	52.1	42.2	−10.5	−5.7	0.22
Duplicate negative	5372	2.12	3.30					
Master positive	5302	1.96	2.58	53.2	42.5	−11.3	−4.7	0.22
Duplicate negative	5372	2.61	3.30					
Master positive	5302	2.48	2.58	53.8	43.1	−12.2	−5.6	—
Duplicate negative	5372	3.22	3.30					
Final Print: 5302, D_p 1.27								
Master positive	5302	1.96	2.58	53.3	44.3	−11.2	−5.8	0.17
Duplicate negative	5302	1.88	2.66					
C. Prints of Duplicate Negatives, Original Negative: 5372, D_N 2.79								
Final Print: 5302, D_p 1.74								
Master positive	5372	1.50	3.50	36.1	32.3	−13.8	−17.9	0.20
Duplicate negative	5372	0.92	3.48					
Master positive	5372	2.05	3.50	42.6	37.8	−13.4	−8.6	0.26
Duplicate negative	5372	1.57	3.48					
Master positive	5372	2.53	3.50	50.5	40.8	−12.4	−6.8	0.31
Duplicate negative	5372	2.10	3.48					
Master positive	5372	2.96	3.50	53.0	41.8	−13.3	−6.2	0.28
Duplicate negative	5372	2.61	3.48					
Final Print: 5302, D_p 1.73								
Master positive	5302	1.55	2.58	49.9	40.1	−13.2	−7.1	0.24
Duplicate negative	5372	2.01	3.30					
Master positive	5302	1.96	2.58	50.2	41.2	−12.7	−6.3	0.22
Duplicate negative	5372	2.47	3.30					
Master positive	5302	2.48	2.58	52.8	42.6	−12.6	−6.3	0.22
Duplicate negative	5372	3.09	3.30					
Final Print: 5302, D_p 1.81								
Master positive	5302	1.96	2.58	51.6	43.3	−12.3	−6.7	0.18
Duplicate negative	5302	1.91	2.66					

*Unmodulated unbiased track.
†Modulation 10,000 c.
‡Output volume levels of 1,000-c print sections relating to reproducer output level at 100% light modulation.
§Prints with −32.5-db cross-modulation distortion.

dependent on the printing equipment and the pitch of the film used in the printing steps.* It is normal practice to "short-pitch" sound-recording negative film by 0.20% to have the correct pitch differential when printing directly on release-print stock. Only two film pitches are available, those found on negative and print stocks; therefore, any condition other than printing from negative stock to print stock will not have proper pitch differential. Some printing steps in the duplicating system must be made with an incorrect pitch differential. The nature of the mismatch in film-pitch differential and the step in the duplicating process where the mismatch occurs will affect the amount of amplitude modulation present in the final print. A minimum amount of amplitude modulation was present in the prints of duplicate negatives when the original negative, master positive, and duplicate negative were all on Type 5372 Film, which is short-pitched.

Because the amount of amplitude modulation present in prints will vary from laboratory to laboratory, amplitude-modulation data are not reported in detail. In the tests made with the equipment in these Laboratories, direct prints of the original negatives had 2% amplitude modulation. The use of Type 5372 Film for both master positive and duplicate negative resulted in prints with an average of 6% amplitude modulation. The test of Type 5302 Film for master positive with Type 5372 Film and Type 5302 Film for duplicate negatives resulted in prints with about 8.5% amplitude modulation. The amount of amplitude modulation present in the prints of duplicate negatives tended to be 2 to 5 times as great as the amount of amplitude modulation present in the direct print of the original negatives.

*J. Crabtree, "Sound film printing," *Jour. SMPE, 21:* 294-322, Oct. 1933.

Conclusions

The factors influencing the sound-recording quality of prints made from duplicate negatives were investigated. The two photographic materials tested, Type 5302 and Type 5372, although of different sensitometric characteristics, were suitable for use as master positives and duplicate negatives. No one set of duplicating density conditions produced optimal quality for all of the sound-recording characteristics simultaneously. A compromise resulting in near-optimal sound quality measured by each test can be made with some latitude in master positive–duplicate negative density. The optimal densities required for the duplicating processes will vary from laboratory to laboratory, depending in large part on the printing equipment and processing conditions used.

Discussion

George Lewin (Army Pictorial Center): Recalling that all these tests were made with the cross-modulation using 9500 cycles, did you correlate them in any way with what actually was heard if you ran some dialogue under those conditions?

Mr. Finkle: No, we did not make listening tests.

Mr. Lewin: I think it's important to point out that many people have already noticed — I think I was one of the first, quite a few years ago — that a particular frequency doesn't always correlate with the best sibilant distortion on variable-area film. For example, we have found that if we used 9000 cycles, which we used to do, we generally ended up with beautiful-looking curves but horrible sound, and we found that if we compromised and used something like 7000 cycles, results were a lot more realistic. This seems very important because other people have been even more emphatic than myself; they go so far as to say that you just cannot find an optimum point for variable-area to accommodate every type of voice, and this should be given a lot of consideration.

Mr. Finkle: In this work we used the cross-modulation test as a control with which to study variations in the sensitometric handling of the film. No direct application to optimal recording conditions should be inferred. A 9500-cycle carrier frequency was used because it makes the cross-modulation test critical in terms of optimal density latitude.

Mr. Lewin: The point is, you might use a frequency so high that it does not correspond at all with the peak frequency of the sibilance in a particular voice that you're faced with recording. Would you repeat your explanation of that noise behind the signal?

Mr. Finkle: Along the edge of an exposed area in a variable-area-type track is an area of graded density. This area of graded density can be a source of noise. The area of graded density present is a function of the recorded frequency. The frequency of these noise components is independent of the recorded frequency. In our test procedure, a 10,000-cycle signal was used to obtain a track with a long edge. A 1000-cycle signal was used as a reference track. Both tracks were played back through a system restricted to a frequency range of 500 cycles through 8000 cycles. The output levels of the two tracks were compared and called signal-to-noise ratio in the presence of modulation.

Joseph T. Tykociner: Pioneer in Sound Recording

By JOHN B. McCULLOUGH

Professor Joseph T. Tykociner, now 90 years old, demonstrated his system of recording sound optically by means of a variable-density soundtrack in 1922. During that year he held one of the earliest public showings of talking motion pictures. His early background and later achievements are described.

On June 9, 1922, Prof. Joseph T. Tykociner of the University of Illinois presented one of the first public exhibitions of sound on motion-picture film. This did not, of course, represent the materialization of an entirely new idea. Such scientists as Edison, Lauste, Case, Sponable and De Forest had been interested in research leading to the goal of talking pictures before that date. The 1922 sound-on-film demonstration followed approximately one year of developmental work at the University (with a reported budget of less than $1000.00) but the idea of sound-on-film seems to have been in Tykociner's mind for nearly a quarter of a century. During those years the development of the electronic equipment that made it possible to put his ideas into effect was gradually taking place.

Joseph Tykocinski-Tykociner is a quiet, thorough scientist of great warmth and humanity. He is now retired, but despite his 90 years, he is still interested in scientific problems. At present he is studying phenomena associated with high voltage discharges through rarefied gases and their resemblance to the colors in the Aurora Borealis.

He was born in Poland in 1867. His father was a grain broker whose fervent hope it was that his son would follow in the family business. This hope was doomed when young Joseph, according to a later account, chanced upon a French magazine describing in words and pictures the telephone. The boy's older sister translated the article and the whole pattern of his future life was set. The impressions formed from this literary encounter were reinforced when Tykociner traveled to Warsaw and there had the opportunity of examining an actual telephone in operation. He was also impressed by the lights of that city which,

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for the first time, was electrically illuminated by means of arc lamps.

His father strongly opposed his desires for scientific training, and at the age of 18 the son abandoned home ties and emigrated to America. His scientific mind was ready for absorbing further technical advances of the time. The crude Edison phonograph aroused his keenest interest and he recognized a challenge to develop more accurate sound reproduction.

In 1897, while he was living in New York, he saw his first motion picture and the possibility of combining sound in synchronism with its visual images may then have occurred to his agile mind. During his years of service in the electrical industry this possibility continued to be a challenge.

He first experimented with a manometric flame with the thought of photographing on a moving film strip the fluctuations caused by the impingement of sound waves on a diaphragm. His plan was to run this film record, after processing, through a mechanism incorporating a light source which would pass through the variable density of its photographed sound image to the then crude selenium cell. Problems arose from the lack of inherent sensitiveness in the selenium cell and the nonexistence of the amplifying and electronic devices for proper reproduction.

In 1900 Tykociner's father relented and he returned to Poland where he finally began formal scientific training. Early in the century he became associated with the British Marconi Company as a junior engineer and later served with Telefunken in Berlin. A few years later he was asked to organize the wireless department of Siemens & Halske in Russia, and shortly thereafter became its Chief Engineer and Manager of Research. He pioneered in short wave radio and was successful in equipping the Russian Navy with wireless equipment prior to the 1904 Russo-Japanese War.

During World War I, he headed the group supplying wireless equipment to the Russian Government, and it was at this time that he made the acquaintance of his good friend Dr. Vladimir Zworykin, who was then in charge of the Imperial Russian Government's Department responsible for the procurement of communications equipment.

With the advent of the Bolshevik regime, he escaped to his native Poland and was successful in organizing its first wireless communication system.

In 1920 he returned permanently to the United States where he once again met Dr. Zworykin. In 1921 he became the first research professor of Electrical Engineering for the University of Illinois. Professor Ellery B. Paine, then head of the University's Department of Electrical Engineering, one day chanced to question Professor Tykociner regarding a possible project study of his personal choice, and it was only natural that he described his interest in photographing sound on a motion-picture film, stressing his belief that if perfected it would provide an entirely new educational and entertainment medium. Factors which aided this experimentation were the availability of the stable and sensitive photoelectric cell invented in 1913 by Professor Jakob Kunz, of the Department of Physics of the Univ. of Illinois, and a mercury vapor lamp that could be modulated for recording. These developments plus the availability of recently perfected vacuum tube amplifiers and oscillators were all needed to make his dream come true.

Development work proceeded rapidly, and he was able to give his first public demonstration by projecting and reproducing a composite print of both motion-picture and variable-density soundtrack before the Urbana Section of the American Institute of Electrical Engineers on June 9, 1922. It should be noted that Professor Tykociner never patented his devices nor was there any profit to either himself or the University of Illinois from this development. The sound reproduced was far from perfect, but it proved that the system would work provided there was additional electronic improvement. This demonstration, based on his studies,* heralded the advent of sound on film processes later brought to a higher stage of development.

Acknowledgments

The author wishes to express appreciation for valuable advice and assistance to Dr. Arthur Wildhagen of the University of Illinois, Vladimir Zworykin, Joseph E. Aiken and Edward W. Kellogg.

*J. Tykocinski-Tykociner, "Photographic recording and photoelectric reproduction of sound," *Trans. SMPE, 16:* 90–119, May 1923.

Editorial Note: *Following the presentation of this paper at the 1957 Fall Convention at Philadelphia, the Tykociner film was shown. It is the Society's good fortune that the only existing 35mm print of this experimental film had been secured by Mr. McCullough before it had decomposed beyond reclamation. Crude by present standards, talking and projection speeds vary so widely that it is impossible to reproduce its feeble sound recording in a modern projector. The task of reproducing the sound on this historic film was assigned to Joseph E. Aiken, who also was personally acquainted with Prof. Tykociner. In the following paper, Mr. Aiken describes the technical problems involved in carrying out this assignment.*

Technical Notes and Reminiscences on the Presentation of Tykociner's Sound Picture Contributions

By JOSEPH E. AIKEN

The task of reproducing the sound on the historic film of Prof. J. T. Tykociner presented certain technical problems. These problems are described. The author's recollections of the sound on film demonstration in 1922 and his recollections of a personal association with Tykociner are recounted.

THE TASK of reproducing the sound on the historic film of Prof. J. T. Tykociner was a very welcome assignment, since the author had a brief personal association with him at the University of Illinois in 1921 and 1922 while he was conducting his experiments. At that time the author was a candidate for the degree of Bachelor of Science and for a thesis had built and was operating the University's first broadcasting station which employed the only two 50-w vacuum tubes on the campus. Professor Tykociner was permitted to borrow these tubes during the day with the agreement that he would return them before any evening broadcasts. This was a satisfactory arrangement except on one occasion when it was necessary to burglarize the Professor's laboratory in order for the station to go on the air.

The basic features of the recording system developed by Tykociner are described in his paper published in the *Transactions* of this Society in 1923 (referred to in the preceding paper). It is shown that exposure on the film was made by a modulated mercury vapor lamp, and reproduction of sound was by means of the photoelectric cell which had been developed by Prof. Jacob Kunz at the University. It is recalled that he used a carbon-grain telephone transmitter for a microphone, and an early Magnavox speaker with upright "morning glory" horn for reproduction. His

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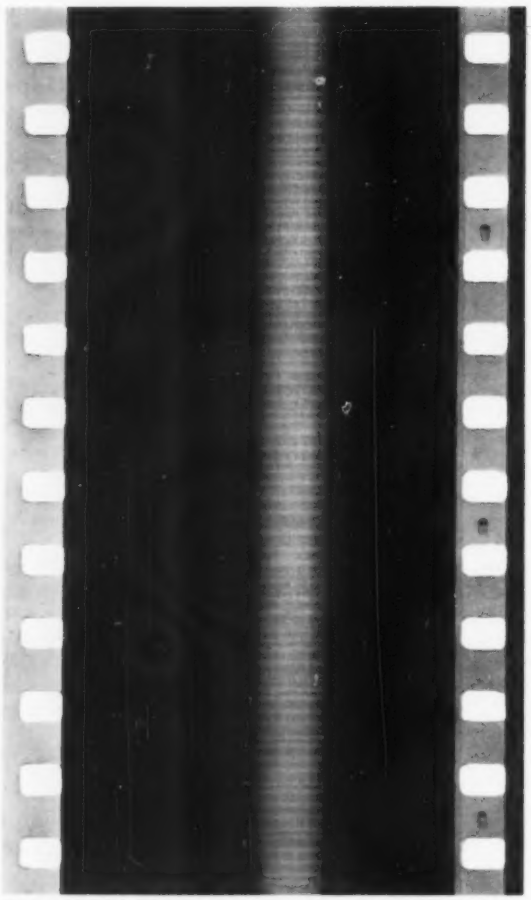

Fig. 1. Soundtrack recorded by Tykociner in October 1921.

Fig. 2. Typical Tykociner soundtrack and picture.

penthouse sound recorder, mounted on a Bell & Howell "Professional" camera constituted an early "single system" equipment. He used a Simplex projector with the sound system mounted above the picture mechanism rather than below as in present practice.

Reproduction of the sound from the Tykociner film is handicapped by the location of the soundtracks which prevents their being played on a modern projector. His first recording, made in October 1921, placed the soundtrack down the center of the film (Fig. 1). In this recording, the Professor's voice announced that this was "an experiment in the reproduction of sound" and he counted numbers up to ten, concluding the test with a loud, "Hello!" Undoubtedly this is one of the oldest intelligible sound-on-film records which has been preserved. Figure 2 illustrates the track placement in all subsequent recordings. Here, the track is on the side of the film opposite from modern practice. It is approximately 0.155 in. in width and its outer edge is placed 0.125 in. from the edges of the sprocket holes. Thus, even with the film threaded in a reversed, or "turned over" position in a modern projector, the track is not scanned. Tykociner used several different film speeds and those examined were made at some higher rate than the present 90 ft/min.

Tape recordings to play at normal speed were made from some of the Tykociner film for the Historical Committee and were demonstrated at the 82d Convention in Philadelphia. To reproduce the track in the middle of the film (Fig. 1) the optical system of a Moviola reader was modified for center scanning and was clamped in a horizontal position on the side of a Westrex RA-1570 Re-recorder which served only as a film transport. With the re-recorder operating at 90 ft/min, the sound was transferred to a $\frac{1}{4}$-in. tape with Rangertone synchronizing pulses. In reproducing the sound of the violin scene (Fig. 2) it was found that the lateral adjustment of the optical system of the RA-1570 Re-recorder was sufficiently flexible to move the scanning into the soundtrack region when the film was threaded in a reversed position. To reduce noise caused by double exposure with picture on the inboard edge of the track, only the outboard 0.100 in. of the track was scanned. This sound was also transferred to $\frac{1}{4}$-in. tape with Rangertone synchronization.

It was necessary to devise means by which these tape recordings could be played back at continuously variable speeds. The Rangertone synchronizing system driving an Ampex Model 350 recorder was modified so that the inverter was fed from a variable-frequency oscillator instead of the usual corrected 60-cycle signal from the synchronizer. Thus, the speed of the tape could be made to vary over a wide range.

The reproduction speed of the tape recording of Tykociner's voice was established solely by ear, choosing a speed that seemed to provide the most natural voice pitch. The tape speed of the violin scene was established with more accuracy. The picture was shown to a violinist in repeated screenings who observed the fingering until he was able to write down the notes which were played by the original violinist. A recording of the modern violinist playing these same notes was made on 35mm magnetic film at standard speed. Then by listening to the Tykociner tape from one speaker, and comparing it with the new recording heard from another speaker,

there was no difficulty in varying the frequency of the oscillator until the two recordings were brought into exact pitch. Finally the Tykociner sound on the tape was transferred at the newly established speed to a tape recorder operating at the standard speed of $7\frac{1}{2}$ in./sec.

By multiplying the ratio of the oscillator frequency to 60 cycles by 90 ft/min, an approximation of the original film speed used by Tykociner was made. This proved to be 102 ft/min for the first voice recording, and 162 ft/min for the violin scene. Credit is due Jack C. Greenfield for the details of these procedures.

These tape recordings are not an accurate representation of the original quality and intelligibility of Tykociner's sound on film. By 1954 the only surviving Tykociner film was a print on nitrate base film which was in an advanced stage of decomposition. A dupe negative was made at that time and the print was destroyed. These tape recordings were made from a print from this dupe negative. Without question, some of the original quality of the variable-density soundtracks has been lost and the signal-to-noise ratio has suffered. The author witnessed the demonstration given at Urbana on June 9, 1922, and another demonstration on Municipal Pier, Chicago, in July 1922. Some scenes are recalled which are not included in the surviving film. There is a distinct recollection that the speech was intelligible throughout.

An Analytical Evaluation of the Lenticular-Plate Cinemicrograph and the Image-Dissection Process

By CHARLES M. HUGGINS

The performance to be expected from an image-dissection high-speed camera is discussed. It has been shown that these cameras sometimes appear to be about threefold faster than would have been simply predicted from the optics and mechanics of the system. A more detailed study of the system shows the apparent increase in time resolution to be real. Generalized equations for the time resolution of image-dissection cameras are presented and these equations are numerically solved for two important standards of performance. Using the known properties of the lenticular-plate cinemicrograph, its speed was evaluated at 100,000 frames/sec. It is also shown that this is based upon a quite conservative definition of framing rate.

Several varieties of high-speed cine cameras have been built utilizing the principle of "image-dissection." This process has the inherent advantage of high framing rates using basically simple mechanical systems. The elementary technique is quite straightforward; some mechanical or optical device is used to break the projected image into a regular array of small, widely-spaced lines or dots. These elements then form the initial image in halftone. If the individual elements are small compared to the distance between elements, then the copy is mostly clear space. The array of elements is then shifted to an unexposed portion of the emulsion and the process continued until all the available emulsion is exposed. The film or plate is processed to produce a "composite negative" which has the several frames interspersed. This negative is viewed through the same optical-mechanical system which serves to select only those elements belonging to a particular frame. It is obvious that, if the individual frames are exposed and played back in sequence, the result is quite similar to conventional cinematography.

The practical details of image-dissecting cameras are treated in several references and will not be repeated here.[1-3] The following method of evaluation will, with suitable modification, apply to the several varieties of image-dissection cameras; however, only the system devised by Courtney-Pratt[4,5] will be treated in detail. The proven merit of other systems by Sultanoff,[6] O'Brien and Milne,[7] Tuttle,[8,9] as well as the novel applications by Lunn[10] and Viard,[11] make such an analysis seem worthy.

A two-dimensional system of image-dissection using lenticular plates to produce the dot structure has been described.[4,5] The image is projected onto the front surface of an array of spherical lenslets; each lenslet converges the light falling on its surface into a small dot at the focus point. Succeeding frames are produced by mechanically traversing the photographic plate with respect to the lenticular plate (Figs. 1(a) and 1(b)). The effective framing rate of this system should be easy to predict. Given a dot diameter, ϵ, and a tracking velocity, V, then one might suppose the framing rate, R, to be simply $R = V/\epsilon$; that is to say that the plate has to be moved a distance equal to the width of an individual element in order to record a new frame. Similarly, the total number of frames, N, that can be recorded on a single pass is limited by the tracking distance, L, and the element width: $N = L/\epsilon$.

In practice, this criterion does not seem to be valid. For example, F. E. Tuttle[8] described a one-dimensional image-dissection camera using 0.001-in.

A contribution submitted on April 4, 1958, from Charles M. Huggins, General Electric Co. Research Laboratory, P.O. Box 1088, Schenectady, N.Y.

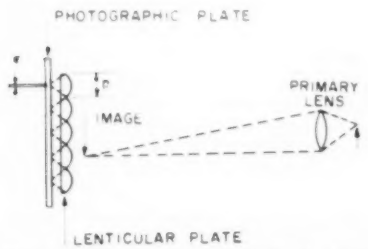

Fig. 1a. Optical diagram for lenticular-plate image dissection. The total light falling upon a given lenslet is condensed to a small dot at the emulsion.

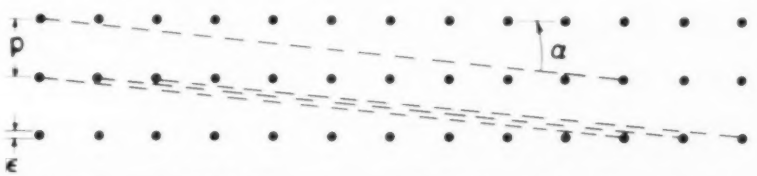

Fig. 1b. The array of black dots represents a single "frame" in halftone. The photo plate is traversed so that each lenslet tracks along the dotted line. The track angle, α, is adjusted so that each track is well resolved by its neighbors.

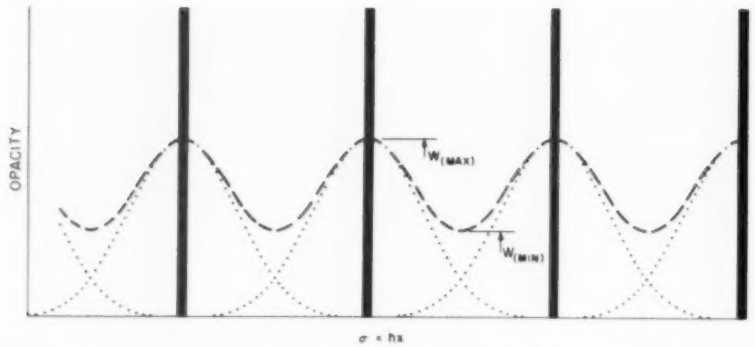

Fig. 2. Emulsion opacity produced by a series of narrow light pulses. The solid lines represent a series of infinitely narrow light pulses, each of which would have been broadened into a Gaussian as indicated by the dotted lines. The cumulative effect is shown by the dashed line.

slits spaced at 0.030 in. With a given set of springs this system should produce 30 pictures at 16,000 frames/sec. However, it was later decided that it was necessary to move the grid plate only 0.0003 in. in order to produce visible motion of the image[9]; hence, the camera was rated for 90 pictures at 48,000 frames/sec, no change having been made in the mechanics of the system.

A similar anomaly has been observed in the operation of the lenticular-plate cinemicrograph.[5] The lenticular plates have been reported to be capable of producing dot elements with a half-width of 0.002 cm when used on Ilford process plates.[12] The tracking velocity of the plate is 150 cm/sec. Here, the framing rate predicted from $R = V/\epsilon$ is only 75,000 frames/sec; the total number of frames produced would be 200 (using a tracking angle, α, of 1:10). However, on photographs of fast-moving, well-defined particles it is possible to observe distinct motions of these particles corresponding to only 3×10^{-6} sec, equivalent to a framing rate of 330,000 frames/sec. Clearly, such discrepancies warrant a more detailed analysis of the performance to be expected from an image-dissection camera.

Analysis of Image-Dissection Process

The lenticular-plate cinemicrograph produces dot elements which are extended in a track as shown in Fig. 1(b); hence, continuous rather than distinct transitions will be observed. This is reflected in a change of optical density along the track as a result of a similar change in light levels as the track was formed. If the individual lenslets and the photographic emulsion were capable of producing points, then the framing rate (or time resolution) of the system would be infinite; however, the dots are blurred by both lenslet imperfections and emulsion spread.

For computational convenience, it shall be assumed that the element opacity can be described by the Gaussian function,

$$W(x) = K \frac{h}{\sqrt{\pi}} e^{-h^2x^2} + 1, \qquad (1)$$

where h is the "precision index" and x is distance from the element center. It will also prove convenient to simplify Eq. (1) by dropping the second term, which approximation is sufficient for a usable range of emulsion density.

$$W(x) \approx K \frac{h}{\sqrt{\pi}} e^{-h^2x^2} \qquad (2)$$

Functions other than Gaussian might be equally likely for this system, but the qualitative features of the arguments to follow are not particularly sensitive to the choice. The use of this function does assume that the opacity of the emulsion is linear with incident light flux (i.e., $\gamma = 1.0$). Similar equations can be derived for other values of γ, but these simpler expressions are adequate for illustrative purposes.

Given Eq. (2) as a representation of the track opacity for a "still" exposure, the track opacity can be predicted for a moving exposure if the time dependence of the incident light is known. Let the incident light be given by $I = f(t)$. Now, since a given lenslet tracks at a constant velocity, v, the light incident at a given point of the track is $I = f(y/v)$; where $v = y/t$ and y is measured in distance along the track. The emulsion opacity of a point, x_1, on the track will then reflect the sum of the light incident at the precise time the lenslet passed over that point plus the Gaussian "tails" from neighboring points. Summed over all such neighboring points, the overall opacity, $W(x)$, becomes

$$W(x) = K \int_{-\infty}^{\infty} f\left(\frac{y}{v}\right) \frac{h}{\sqrt{\pi}} e^{-h^2(x-y)^2}\, dy. \qquad (3)$$

In the most general examples, this expression cannot be integrated in closed form; however, a few special examples will suffice for present purposes.

Example 1

A suitable, although arbitrary, standard for framing-rate or time resolution of a high-speed camera might be the maximum frequency of a flashing light which can just be resolved. If the light pulse has a small half-width, $f(y/v)$ can be represented by a series of regularly-spaced delta functions. Upon substitution, Eq. (3) can be numerically plotted from published tables.[12] Figure 2 shows the effect to be expected. For reasons which will become clear, the linear displacement is measured in the dimensionless unit, $\sigma = hx$, where h is the "precision index" as in Eq. (2).

An inspection of the opacity curve in Fig. 2 points out the root of the anomaly in framing rate. The dashed curve represents the variation in light intensity that will be presented upon playing back the cine record of the series of narrow pulses. Assuming a linear emulsion, some modulation would be observed even for infinitesimal separation. Conversely, total modulation would never be possible. Consequently, it becomes necessary for one to define a suitable standard of resolution. Equation (3) can be solved for the separation necessary to produce any given modulation. For separations comparable to the half-width, it is necessary to consider only adjacent pulses. The change in opacity is then given by

$$\frac{W_{max}}{W_{min}} = \frac{1 + 2e^{-\sigma^2}}{2e^{-\sigma^2/4}} \qquad (4)$$

or, to sufficient accuracy,

$$\sigma = 2\left[\ln \frac{W_{max}}{W_{min}}\right]^{1/2}. \qquad (5)$$

Thus, Eq. (5) defines the separation necessary to effect a given modulation of opacity. With measured values of the tracking velocity and element size, a maximum time resolution or framing rate can be predicted.

Example 2

Probably a more meaningful and useful measure of time resolution is as follows. Suppose an opaque object is suddenly injected into the field. How long thereafter before this is known? This is equivalent to a steady light being turned off at $t = 0$. One might be tempted to assume that the density would decrease with the same Gaussian contour as determined for the individual elements. However, upon normalization to $W(-\infty) = W_{max}$, Eq. (2) becomes

$$W(\sigma) = W_{max}\left[\frac{1}{2} - \frac{1}{\sqrt{\pi}} \int_0^{\sigma} e^{-y^2}\, dy\right]. \qquad (6)$$

The effect of a light suddenly turned on at $t = 0$ is identical with a change in sign. It is shown in Fig. 3 that this function decreases considerably different than Gaussian and does not approach W_{max} at $\sigma = 0$. Obviously, the time indeter-

minateness in observing the opaque object depends entirely on the selection of an arbitrary decrease in opacity and the reproducibility in measuring this decrease.

The standard of time resolution shall be chosen so as to be comparable with Example 1. Suppose an opaque object is injected into the field, left for a finite time, and then suddenly removed. The corresponding incident light pattern and the overall emulsion opacity is shown in Fig. 4. It can be seen that, here again, the observed modulation would never be 100% and that any infinitesimal separation would cause a correspondingly small modulation. The actual modulation to be expected is shown in Fig. 5, which gives the separation of light pulses necessary to effect any required modulation of opacity.

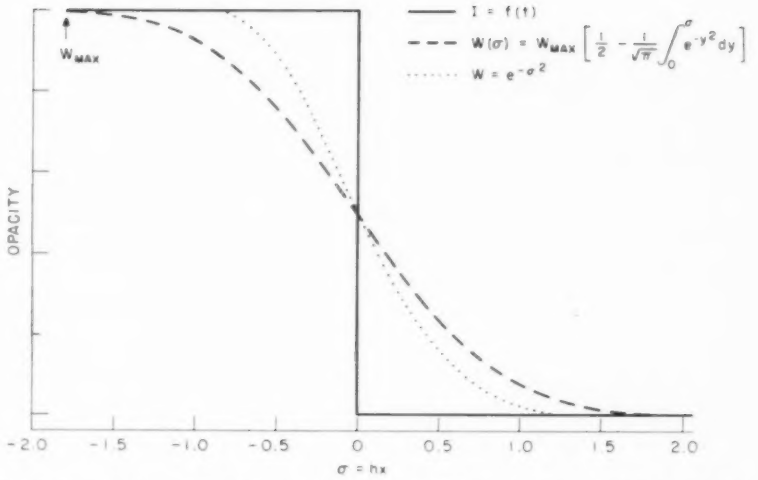

Fig. 3. Opacity decay following a wide rectangular light pulse compared with Gaussian decay.

Application to Lenticular-Plate Cinemicrograph

The principles and performance of the lenticular-plate image dissection camera have been discussed previously.[4,5] However, the performance should be reexamined in view of the present arguments. The set of spherical lenslets is formed by crossing a pair of cylindrical lenslets supplied by M. R. Marilet.[14] The optical properties of these lenslets were investigated in some detail by J. S. Courtney-Pratt.[12] With minor exceptions arising from differences in optical geometry, the results of that study are applicable here.

If these lenslets produced point foci, then the framing rate of the system would be infinite. In practice, the dots formed on the emulsion have finite width arising from several causes: image of primary lens aperture, diffraction, lenslet imperfection, and emulsion spread. The width of aperture image, ϵ_1, is directly calculable from $\epsilon_1 = Da/A$, where D is the diameter of the primary lens, a is the lenslet-emulsion distance, and A is the primary lens-lenslet distance. For the cinemicrograph, $\epsilon_1 \simeq 0.0003$ cm. Broadening due to diffraction and lenslet imperfections, ϵ_2 and ϵ_3, can be combined into a measured quantity. Courtney-Pratt[12] determined the resolution of the lenslets to be 0.00054 cm, using off-axis illumination. For the present special case of only on-axis illumination, it is supposed that resolution is improved to say, $\epsilon_2 + \epsilon_3 = 0.0004$ cm. Emulsion spread, ϵ_4, is determined by choice of emulsion and developing technique. With process plates and standard processing, resolution of 100 lines/mm is quite reasonable; hence $\epsilon_4 = 0.001$ cm.

The final width is, then, the sum of these perturbations. If it is assumed that each factor, ϵ_i, can be represented by a Gaussian, then the mechanism for summing is simple. Let each perturbation be

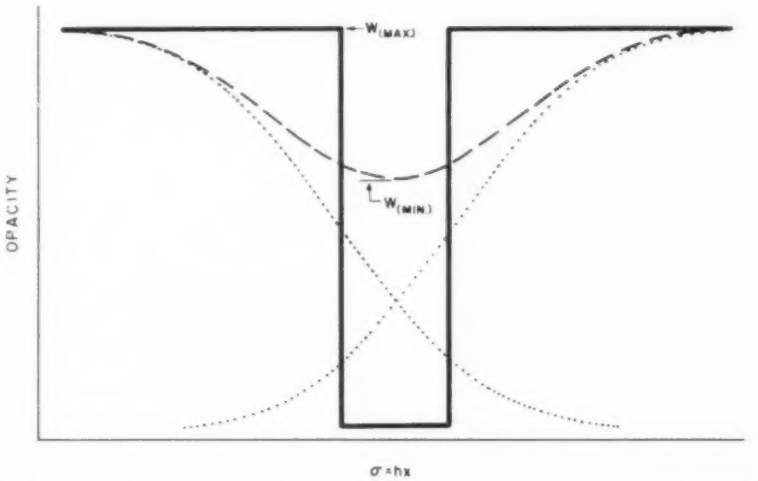

Fig. 4. The solid line represents the light pattern caused by an opaque object injected into the field for a finite time. Each light pulse is broadened into the corresponding dotted lines, the sum of which is shown by the dashed line.

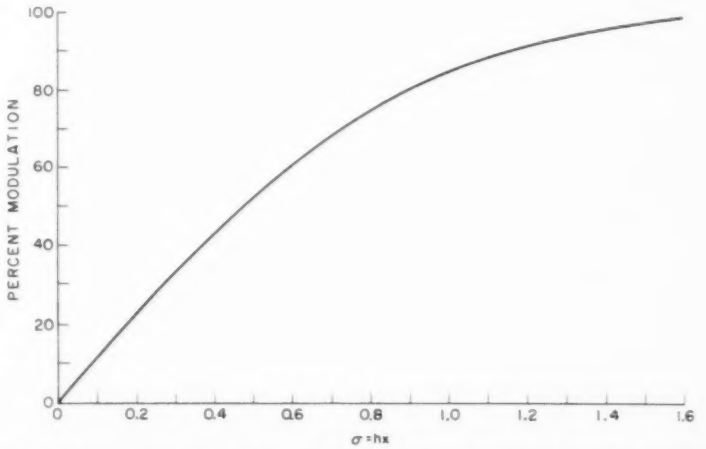

Fig. 5. The per cent modulation effected by a given separation of wide, square light pulses.

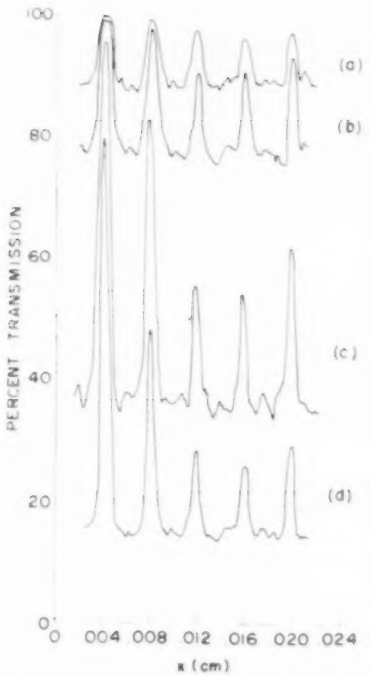

Fig. 6. Transmission traces of 40× negatives made from a cinemicrograph composite plate showing the opacity contours of five elements. The exposure times were, in order: (a) 0.02; (b) 0.04; (c) 0.10; and (d) 0.20 sec.

$$W_i = \frac{h_i}{\sqrt{\pi}} e^{-h_i^2 x^2}.$$

represented by a Gaussian distribution, The cumulative effect[15] of several independent Gaussians can be shown to be

$$W = \frac{H}{\sqrt{\pi}} e^{-H^2 x^2}, \qquad (7)$$

where

$$\frac{1}{H^2} = \sum_i \frac{1}{h_i^2}. \qquad (8)$$

The precision index, h_i, is related to the half-width, ϵ_i, by the relation, $\epsilon = 1.668/h$; hence, $\epsilon^2 = \Sigma \epsilon_i^2$.

Again, other functions might be equally likely, but the qualitative features are not sensitive to the choice. However, in other image-dissection systems, the relative importance of the various terms might be shifted. It is worth noting also that Eq. (8) weights most heavily the leading terms; that is, the increment caused by less-important effects is less than would be assumed from linear additions. This should be remembered in any attempt to improve performance so that the major effort would be applied to the more important term.

Using the above values for the ϵ_i's, a cumulative width of $\epsilon = 0.0011$ cm is predicted. Conventional densitometers do not have the necessary resolving power to map accurately the contour of such an element. In an effort to measure the element size experimentally obtained, the following procedures were used. Photomicrographs of a selected composite plate were made at 40 diameters magnification on Kodak Process Plates developed in Kodak Developer D-11 diluted to 50% strength. Successively increasing exposures were made in order to insure that the accepted negatives included the absorption maxima and minima on the linear part of the H&D curve. A Jarrell-Ash No. 2310 Microphotometer was used to scan the negatives perpendicularly across a set of five tracks chosen to show a variety of initial exposures. Figure 6 shows the traces as recorded. This particular choice of tracks gives an element half-width of about 0.001 cm to confirm the prediction above. Unfortunately, conditions are not always so favorable; various effects such as improper seating of plate and overexposure tend to broaden the element size. In general, an element size of about 0.0015 cm should be expected; this latter number will be used in future calculations.

The lenticular-plate cinemicrograph has been reported to have a maximum tracking velocity of 135 cm/sec.[5] This speed has been increased to 150 cm/sec and could probably be further increased to 170 cm/sec without modification.

It is now possible to predict a framing rate based on Example 1 or 2. For Example 1, it shall be claimed that it is necessary to effect at least 90% modulation in order to have resolved the light pulses. Solving Eq. (4), $\sigma = hx = 3.5$. Hence, the pulses must be separated by 3.2×10^{-3} cm, corresponding to a time separation of 21 μsec at a tracking velocity of 150 cm/sec. Since both light and dark "frames" are recorded, the time blur is only 10 μsec. A similar analysis of Example 2 can be made. It is assumed that it is necessary to effect a decrease of density of 90% in order to have resolved the pulse. From Fig. 5, $\sigma = 1.2$ for 90% modulation. For 150 cm/sec tracking velocity, this corresponds to a time blur of 7.4 μsec.

Conclusion

It has been shown that it is possible to predict the behavior of an image-dissection camera for various arbitrary standards of time resolution. The general equation was numerically solved for two particular cases: a series of narrow pulses and a wide, square pulse. It is seen that two different standards predict slightly different time resolutions even though the same element sizes and density modulation were assumed. Other standards will again yield varying results. Further, it is not important which is used as long as it is recognized that these differences exist.

Using data previously obtained for the lenticular-plate cinemicrograph, the maximum effective time resolutions were predicted for two examples. For Example 1, the effective time resolution was 10 μsec, corresponding to 100,000 frames/sec. Likewise, Example 2 predicted a time resolution of 7.4 μsec or 135,000 frames/sec.

Since a single figure must, in general, be used to describe an instrument, it is proposed that the cinemicrograph has a maximum effective speed of 100,000 frames/sec. It is to be understood that this is a conservative evaluation; for some phenomena, the performance may appear to be about threefold faster.

Acknowledgments

The author wishes to express his thanks to several of his colleagues, especially F. P. Price, for their comments, and to J. S. Courtney-Pratt for calling attention to an error in the original manuscript.

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New Horizons in Exhibition

Editorial Note — *To give some attention to the challenge of better exhibition, the Society has sought some points of view from Ben Schlanger, Consultant for the new Colonial Williamsburg Theaters where, as reported by Bosley Crowther in the New York Times, spectators ". . . can sense the new horizons for exhibition that can be reached through new, imaginative design." Mr. Schlanger notes:*

Britain's National Film Theatre demonstrates notable advances in design over most motion-picture theaters which, incidentally, were built before the advent of the big, or wide-screen, picture; but it does not represent the ultimate in theater design which has not yet become static.

A worthy effort has been made in the National Film Theatre to neutralize the auditorium shape and interior surface treatment to permit projected pictures to dominate the view of the spectator but, unfortunately, the limited head room under the bridge controlled the size of picture; however, it would seem possible to have a 40-ft wide picture and, given good picture resolution and light, the projection throw could be increased to obtain a favorable focal length for the lenses. A 40-ft wide picture would dominate the scene for the viewer from this seating pattern and the side walls would be further out of range of the average viewer. As an alternate to the special screen curtain there might be an optical or other device for framing the various aspect-ratio pictures. A picture wider than 40 ft could be considered for films larger than 35mm.

This is a good and neat theater design and it succeeds in exhibiting pictures under conditions much less distracting than in most theaters. It has replaced the usual elongated seating pattern with the more nearly square pattern which is economical and essential for wide-screen viewing. We must, however, seek still further to exploit physical and psychological possibilities to attain the desirable design for theaters for today's films. — *Ben Schlanger.*

Great Britain's National Film Theatre

By R. F. SCOTT

It is almost two years since my first meeting with Frank Hazell, of the British Film Institute, and Norman Engelbach, of the London County Council, when Mr. Hazell outlined the project to build a national film theater and invited me to assist with the planning.

The mandate was simple: to build a theater embracing the whole of cinema engineering while providing for the foreseeable future — in short, a challenge, and an opportunity to design a "pure" cinema, unhampered by tradition (Fig. 1).

The choice of the site, under the southern arch abutment of Waterloo Bridge (Fig. 2), gave rise to many planning limitations, all of which have been effectively overcome by the architect.

After the site had been selected, tests were conducted within the bridge vault to determine the level of noise transmitted through the structure of the bridge. This was found to be negligible, so the next step was to study acoustics within the auditorium. The result was a ceiling for the auditorium lined on its upper surface to eliminate, as far as possible, any transmitted noise.

The first stage was to determine the various areas including the main auditorium, small preview theater, projection suite, offices, club rooms and general service areas. Each decision was made on a commonsense basis, uninfluenced by considerations of tradition or fashionable effect (see Fig. 3).

Simple geometry dictated the shape of the main auditorium. The height of the underside of the bridge and a sharply inclined floor under the screen would allow a picture no higher than 12 ft 6 in. The width of the widest ratio, therefore, must be CinemaScope, at 32 ft 6 in.

Experience gained during recent years indicates that the best viewing distance from a screen of these dimensions is between two and five times the height, thus making the front row at 24 ft and the rear row at 64 ft (Fig. 4). The ex-

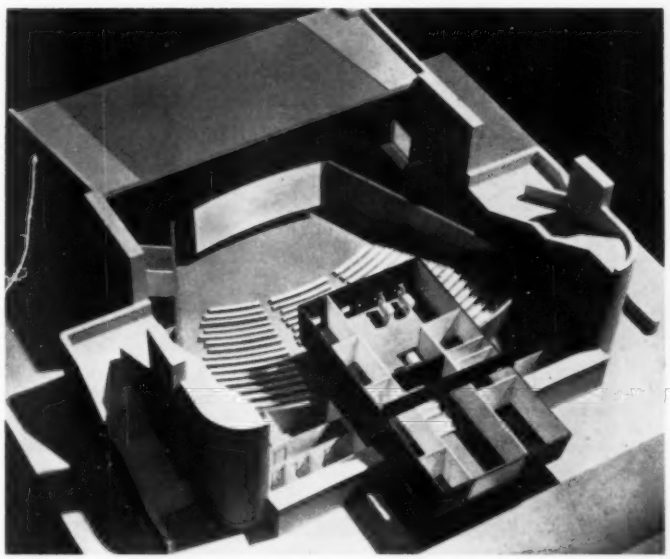


Fig. 1. Model of the National Film Theatre, showing the main auditorium, looking toward the screen. Projection booths in foreground contain equipment for both the main and the preview auditoriums. Preview theater, in foreground, overhangs entrance.

A contribution submitted on November 20, 1957, by R. F. Scott, Planning and Design Dept., G.B-Kalee Division of Rank Precision Industries Ltd., 37–41 Mortimer St., London W1.

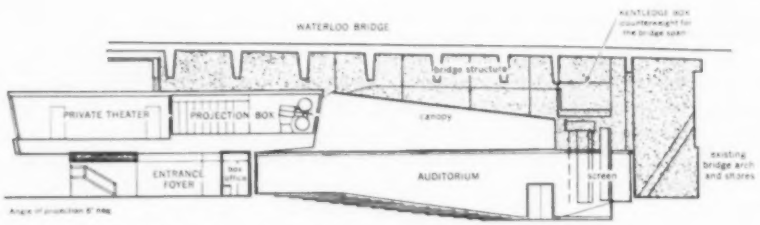


Fig. 2. Planning limitations imposed by the site under Waterloo Bridge.

treme sides of the seating area were determined at the maximum angle from the screen surface taken from the widest picture commensurate with good vision. This angle is 115°. The resulting seating capacity is 500 seats. To provide uninterrupted viewing, the floor of the auditorium was formed by excavation to give a 1 in 8 slope on curved steppings.

The floor is covered with a specially designed carpet in colors of green, black and gray in a nondirectional design. (As far as we know, this 1250-yd carpet is the largest ever laid in one piece on a curved step auditorium floor.) The ceiling and upholstery are a light green color. As a person advances through the foyer, there is a progressive reduction in the lighting to accustom his eyes to viewing conditions. The walls are treated with 3-in. wooden strips modified at certain points for absorption over 20% of the area. Tests and measurements in the auditorium show the volume per seat as 150 cu ft and reverberation times as 125 cycles/sec at 1.3 sec; 500 cycles at 1.0 sec, and 2000 cycles at 0.94 sec.

The screen (Fig. 5) had to provide for all known film systems, so no less than 10 ratios were required. To provide for future developments and give the greatest flexibility, it was decided to place the screen inside the auditorium.

A space frame of tubular construction standing on four 3-in. diameter tubes was designed to suspend the Harkness stereo screen. This screen has a widely diffusive surface and incorporates electrically operated magnascopic masking for varying the width of the picture. The height is common for all ratios, thereby giving an inter-ratio balance.

In order to present the program and to enhance the auditorium, the architect designed a panel of abstract shapes which was made into a two-leafed shutter as part of the screen space frame (Fig. 6). This shutter parts in the center and runs on special tracks to the rear of the screen where it remains during film presentation. The shutter consists of 340 separate panels of 9-mm ply, each surfaced with plastic paint treated to give a broken stucco effect and finished with gilt. The panels are separately hinged and suspended on steel rods.

The entire framework and picture format are covered with a suit of tailored black masking. This latter may be a debatable choice, but experiments have produced no evidence that there is any better color for surrounding the picture; and until the industry decides on one aspect ratio it will be impossible to eliminate masking altogether.

The screen equipment having now emerged from the gloom of back stage and from behind voluminous draperies, and having so to speak "come of age," we have, in keeping with other "scopes" and "isions", given it a name — The Gaumont-Kalee "Monovistal."

As the auditorium will be used for lecture purposes, a sectional staging has been supplied consisting of 15 sections on lightweight tubular beams which are supported in floor sockets over the sloping floor in front of the screen. A sectional box along the front houses lighting and microphone wiring. This staging can be erected or dismantled in a very short time.

The small preview theater, seating 25 people, is situated over the entrance and is unique in providing not only all the screening facilities of the large auditorium (10 ratios), but in addition, a rear-

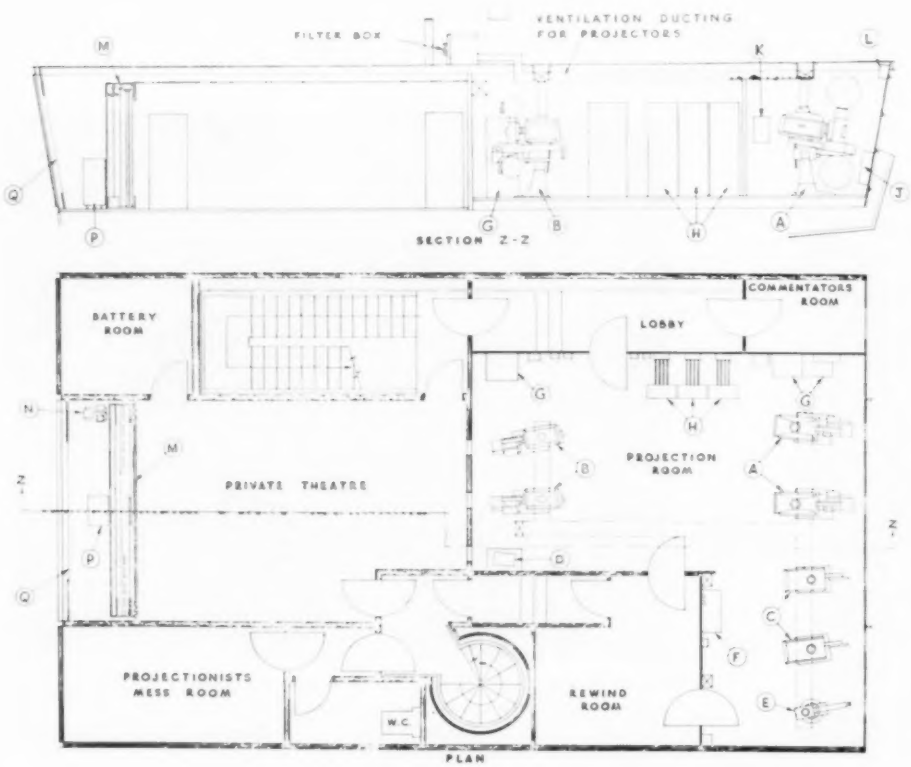


Fig. 3. Projection areas and equipment: A, Gaumont-Kalee "20" 35mm projectors; B, Gaumont-Kalee "18" 35mm projectors; C, G.B-Bell & Howell Model 609 16mm projectors; D, G.B-Bell & Howell Model 630 16mm projectors; E, slide lantern; F, Gaumont-Kalee nonsync record player; G, rectifiers; H, amplifier racks; J, voltage amplifier; K, effects control unit; L, magnetic preamplifier; M, roll-up screen and curtain frame; N, electric curtain controller; P, Type 717 loudspeaker; Q, rear-projection screen.

projection screen to the front of the theater. This could not have been done were it not for the fact that the building is beneath Waterloo Bridge, so that even on the brightest day the plate-glass facia is in shadow. This is of great value for advertising purposes.

This facility gave rise to many problems. In order to project onto the special Harkness rear-projection screen, the normal screen had to be removable. This was accomplished by designing a special tubular steel open-type frame with side electrically operated magnascopic masking. This has a Harkness pull-up roller screen operated by winch gear, with black plastic masking incorporated on the screen at the top and bottom. This framework also carries an orthodox velour curtain and dress legs.

The projection room is situated between the two theaters and serves both, but with completely separate installations. Serving the main theater are two Gaumont-Kalee "20" 35mm projectors, which will run at 16 and 20 frames/sec for silent films, and 24 frames/sec for sound films. They have series "S" lenses and Varamorph variable anamorphic lens for all ratios (Table I). The sound

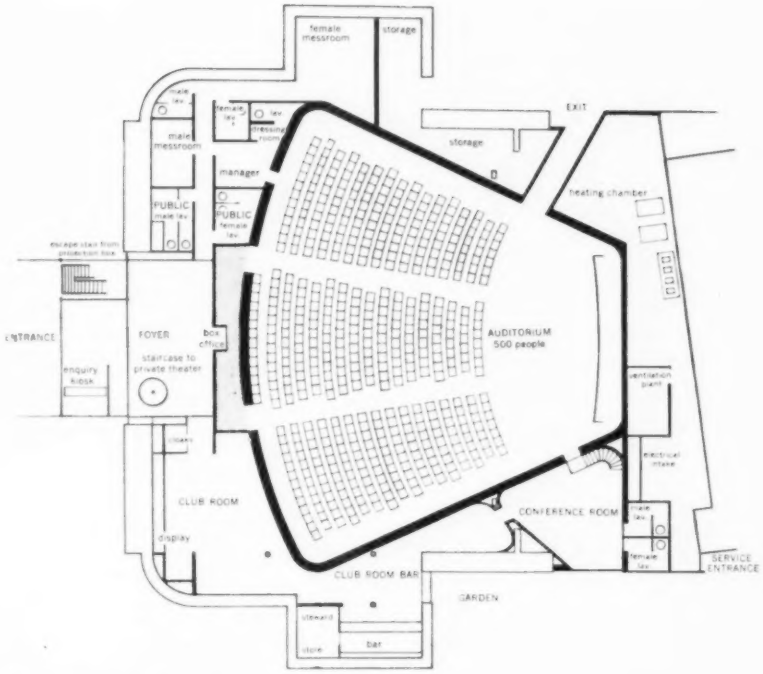


Fig. 4. The main floor plan.

Table I. Projection Data.

Aspect Ratio	Frames/sec	System
	Main Theater, 35mm	
1.33:1	16*	—
1.33:1	20*	—
1.38:1	24	—
1.66:1	24	Wide Screen
1.75:1	24	Metroscope
1.85:1	24	VistaVision
	Anamorphic	
1.75:1	24	VistaVision
2.00:1	24	R.K.O. Scope
2.35:1	24	CinemaScope
2.55:1	24	CinemaScope
Three-dimensional projection		
Unmarried prints		
Sound System		
Optical track		
Magoptical		
Four-track magnetic stereophonic		
Single, double or treble magnetic tracks to CinemaScope track positions.		
	Main Theater, 16mm	
1.34:1	16*	—
1.34:1	24	—
	Anamorphic	
2.68:1	24	—
Sound System		
Optical track		
Half-stripe magoptical		
Full-stripe magnetic track		
Edge-stripe magnetic track		
	Preview Theater	
35mm as for main theater plus rear projection at 1.38:1 on one projector without stereophonic sound.		
16mm as for main theater plus recording facilities for all magnetic tracks.		

* Silent.

Fig. 5. View of screen in full CinemaScope size of 32 ft 6 in. by 12 ft 6 in. The decorative screen shutter is completely out of sight round the back of the screen frame.

Fig. 6. Ordinary ratio screen with Monovistal decorative shutter forming a "setting" for a film.

system is Gaumont-Kalee "21" dual 30-w optical reproducer equipment with the addition of a four-track magnetic stereophonic system, with 10 auditorium-effects speakers and three main speakers behind the screen. Provision has been made for future installations of multi-magnetic/optical track follower heads and interlocks. The arc lamps are Gaumont-Kalee Presidents. The projectors are interlocked for projecting three-dimensional films and unmarried prints, and allowance has been made for future developments in new film presentations as far as is possible.

At the side of the 35mm machines are two G.B-Bell & Howell Model 609 arc 16mm projectors equipped to run at sound and silent speeds and either optical or magnetic track sound reproduction.

The preview theater is served by two Gaumont-Kalee "18" 35mm projectors and dual 18-w sound-film reproducer with Universal arcs; one machine is equipped for rear projection. To provide 16mm projection facilities, a single G.B-Bell & Howell Model 630 equipment specially adapted for long running with both optical and magnetic sound systems and recording facilities on magnetic track is installed.

In determining the position of the projection room, the length of throw and angle to the main screen were the main considerations in order to allow lenses of the most advantageous focal length, which falls within the range of focal lengths of backing lenses that will give the best coverage and sharp focus over the whole picture area. It is possible that some form of television projection may be required in the future.

The angle of projection is slightly negative so that there is no distortion of the projected picture.

Design Improvements in High-Wattage Tungsten Filament Lamps for Motion-Picture and Television Studios

By LEROY G. LEIGHTON and ALFRED MAKULEC

The development of a special-type collector grid for use in high-wattage incandescent lamps used for motion-picture studio lighting is discussed. The collector grid is designed to maintain the beam lumen output of such lamps at a high level until filament failure occurs. Causes and effects of lamp blackening are explained.

SPECIAL PROBLEMS relating to the needs of motion-picture and television studios have long been of interest to designers and manufacturers of tungsten filament lamps. Color film and wide-screen processes have created new requirements, and the advent of color television has resulted in increasingly complex lighting problems. The demands for large quantities of controllable light in compact and quiet packages have been met with a series of studio lamps of high wattage. At General Electric, more than 65% of the incandescent lamps of 2000 w or more are designed for studio lighting or related service.

Studio Performance Problems

Increased use of high-wattage lamps has brought about extensive research aimed at improving quality and performance. Recently, efforts have been directed toward two problems: (1) reducing bulb blackening, thereby improving the lamp beam lumen maintenance and reducing the tendency of bulbs to blister in service; and (2) lessening the amount of audible noise produced by studio lamps on a-c circuits.

Presented on December 10, 1957, at the Hollywood Section Meeting by Leroy G. Leighton and F. E. Carlson, Large Lamp Dept., General Electric Co., Nela Park, Cleveland 12, Ohio.
(This paper was received on February 20, 1958.)

Lamps designed for spotlight service have high-wattage, concentrated filaments in relatively small bulbs. The studio lamps are much more heavily loaded than the lamps made for general lighting purposes. In addition, color film requirements demand high filament temperatures to produce light of satisfactory color characteristics. These design parameters tend to contribute to reduced lamp performance. First of all, the rate of evaporation of a tungsten filament increases greatly as its temperature rises. The high filament wattage results in a larger filament surface from which the tungsten evaporates, and this more rapidly evaporated tungsten is deposited on the bulb wall by the convection stream of the inert gas in the lamp. Bulb blistering and depreciation in beam candlepower are caused primarily by this black deposit. The relatively small bulb sizes required for studio lamps also contribute to poor beam maintenance, first, by the concentration of blackening on the bulb decreasing the amount of light reaching the lens and the mirror, and second, by the blackening absorbing radiation from the filament and causing the already very hot bulb to get even hotter.

When the bulb is in the base down position, the gas stream rises to the top of the bulb and deposits the blackening in a region where, because of the design of the filament, relatively little filament radiation impinges, but as the bulb is tilted, the gas stream still rises vertically and deposits tungsten in an area of greater filament irradiation; the spotlight reflector redirects the energy through the blackened zone. Thus, when a spotlight is aimed down at about 45°, the gas stream in the lamp carries the blackening to an area of the bulb where it obstructs light that would ordinarily contribute to the spotlight beam. As a result, beam lumens are decreased and the bulb temperature is increased.

This increase in bulb temperature due to blackening can, and frequently does, cause a vicious cycle to begin. It is characteristic of many glasses that they will give off small amounts of moisture when heated to high temperatures. When this moisture is released inside the bulb, a "water cycle" is started, causing a more rapid rate of blackening than would occur due to normal filament evaporation. This increased blackening absorbs more radiation, which in turn causes localized bulb temperatures to increase. Soon a point is reached at which part of the glass bulb becomes sufficiently plastic that the internal gas pressure blows a "blister" on the bulb. Spotlight lamp bulbs are heated to the highest practicable temperature during manufacture to remove much of the moisture from the glass. However, after blackening begins in confining spotlights, bulb temperatures may rise high enough to initiate the so-called "water cycle." This situation is at its worst in the 10,000-w lamp. Blistering is often so severe that the bulb glass may touch the spotlight reflector,

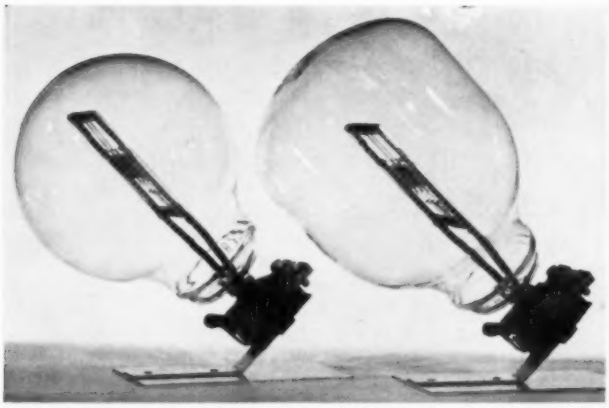


Fig. 1. Tubular bulb (right) for 5000-w lamp, designed to counteract blistering; earlier bulb at left.

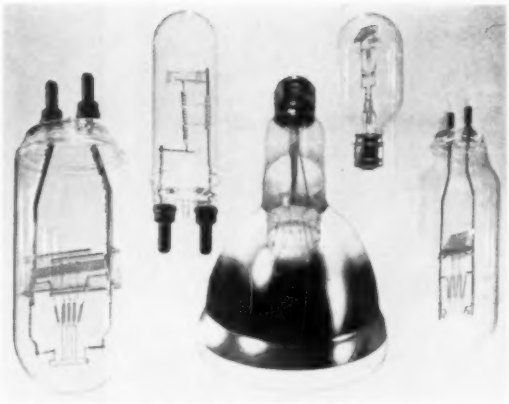


Fig. 2. Typical early collector grid lamps.

causing a crack that ends lamp life. As a result, 10,000-w lamps often must be removed prematurely from spotlight service and relegated to background floodlighting or other services that could be performed by less expensive lamps. It is estimated that 10,000-w lamps are useful in spotlights for only about 40 or 50 hr, although their filaments do not burn out until about 75 hr. In the 5000-w G-64 bulb and 2000-w G-48 bulb lamps, the problems are similar, but not so severe.

A further difficulty sometimes encountered with high-wattage studio lamps is that of noise. This problem is seldom encountered in professional motion-picture studios since d-c power is generally used. Lamp noise became a factor of importance first in TV studios, where alternating current sometimes produced sufficient noise in lamps of 1000 w or more to be picked up by sensitive microphones above the set and near the lighting equipment. This type of noise is often transitory and is not always caused by the same lamp or lighting unit.

Early Approaches to the Problems

One of the major contributions to the reduction of blackening and blistering problems was the introduction several years ago of tubular bulbs for 2000-w and 5000-w lamps. The extended contour of the tubular bulb shown in Fig. 1 is almost directly above the filament when the spotlight is aimed downward 45°. This bulb shape effectively "preblisters" the bulb, locating the hot spot farther from the filament. Blackening in this region interferes less with light that forms the beam. As a result, bulb temperatures are lower, blistering is greatly reduced, and bulb blackening has less effect on the spotlight beam. Unfortunately, this development is not applicable to 10,000-w lamps, since a tubular bulb of preferred contour will not fit in the vast majority of existing 10,000-w spotlights. Shortening the tubular bulb to fit these units does not improve lamp performance in proportion to the increased lamp cost.

An investigation was made to determine whether forced ventilation could sufficiently lower bulb temperatures to reduce blistering of 10,000-w lamps. The first findings were quite encouraging, as the cooling air aimed at the hot spot caused a significant drop in initial bulb temperatures. As the bulb blackened, however, the high rate of absorption of radiation nullified this good effect. Blowers of high capacity (and annoyingly high noise levels) could not remove heat fast enough to prevent blistering. In the face of limited reduction of blistering and no decrease in blackening — and considering the higher equipment cost and noise problems — it was decided to abandon the fixture-ventilation program.

An attempt was also made to reduce blackening and blistering by internal construction changes in the lamp. For many years, lamp designers have used collector grids or screens to improve lumen maintenance of their products (Fig. 2). Thomas Edison was granted three patents during the period between 1881 and 1883 on the use of various forms of collector grids to control bulb blackening. There are about 15 American patents and several foreign patents covering various configurations and arrangements of blackening control devices. Conventional grids have been tried in various studio lamps, including the 10,000-w size, with no success. Conventional grid materials had to be located too far from the filament, due to the temperatures involved, to control blackening effectively in the most critical burning positions.

The noise problem was attacked with some success in studio spotlight and floodlight lamps in the 1000-w to 5000-w range. Solutions varied for individual lamps, but they generally involved the reduction of the amount of magnetic material within the lamps and, in some cases, relocation or rearrangement of lamp parts so as to restrict magnetic effects. As a result, the lamps commonly used in television studios are now available in a "low-noise" line that significantly reduces noise effects. Some noise problems remain, but these are often due to elements external to the lamp, or else due to amplification effects caused by the acoustics of the lighting equipment.

A New Approach to Design of the 10,000-w Lamp

Several years ago, it was decided to approach design of the 10,000-w lamp with a drastic departure from conventional design. It was known that the most effective location for a collector grid is directly above the filament and close enough to the filament to intercept most of the rising gas stream. In many lamps, the screen cannot be ideally located because of construction problems or interference with an optical system.

In considering the 10,000 w lamp, it was felt that locating the grid close enough to the filament should produce favorable results that would outweigh any losses caused by the screen shading a portion of the pickup angle of the mirror. A screen located close to the filament can be much smaller to intercept the gas stream (Fig. 3) and its higher tempera-

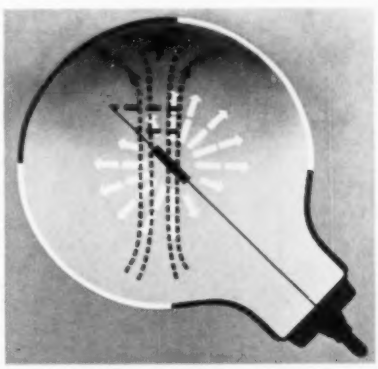


Fig. 3. Thermal gas currents; collector grid at 45° angle.

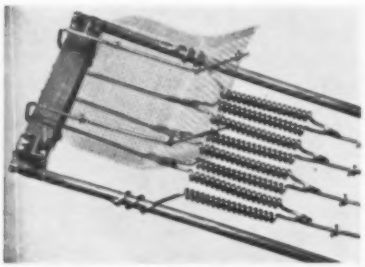


Fig. 4. Close-up of the new collector grid design.

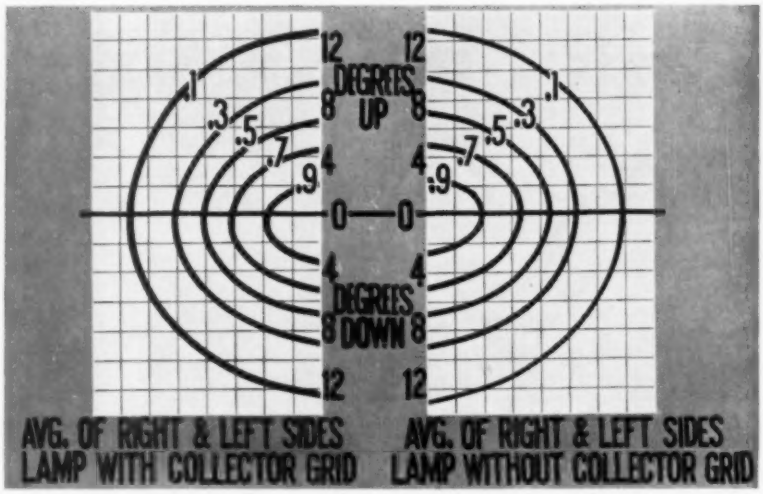


Fig. 5. Comparison of candlepower distribution from typical 10,000-w spotlight with and without grid.

ture improves its effectiveness. In order to withstand the temperatures involved, a special screen of woven tungsten wire was developed.

Early in our development program, practical limitations came into play. In order to obtain significant results, a relatively large number of sample designs had to be built. The resultant demand for power supplies and testing space and equipment meant that test facilities had to be greatly expanded or that the program had to be stretched out over a long period, with tests of only a few lamps at a time. Our test facilities were increased considerably, but a technique, believed to be new to the study of high-wattage lamps, proved to be the greatest timesaver. We decided to build scale models of the large lamps to test more variations in less time and at far less cost than would be incurred by using full-sized lamps. The model used for the 10,000-w lamp was a 1000-w G-30 lamp with a medium bipost base. The model gave us a 10:1 wattage reduction, with about the same bulb loading; many models were made with a variety of screen configurations.

One of the early groups of tests compared the results of burning on a-c and d-c circuits. Results confirmed the opinion that differences were insignificant. Another series of tests sought to determine if it was best to isolate the screen electrically, or to attach it to the positive or negative side of the supply (on d-c circuits). Again there was no significant difference; this was reconfirmed in later tests with full-size lamps. A further approach, that of electrically charging the grid through a third electrode at some other voltage, was dropped because of encouraging improvements made without introducing this expensive and possibly hazardous construction feature.

Every series of tests with the model lamps was consistent in one respect. The better-located collector grid always produced an improvement of 8 to 10% in lamp lumen maintenance over lamps without grids.

When it was clear that a better lamp design had been found, tests of the full-sized 10,000-w lamp were resumed. Our feeling was that measurements of depreciation of total lamp lumens did not represent a true measure of lamp performance. Lamp users are generally interested only in the characteristics of spotlight beams. Therefore, we borrowed a scheme used previously for short-range testing of searchlight beams. A photometric hemisphere was set up and into it the beam from a spotlight was directed. Hemisphere brightness was measured by the output of two matched, color-corrected GE photovoltaic cells connected to a microammeter. Several weeks of checking and calibration were required for results accurate to within about 2%. For all tests the spotlight focus control was locked midway between the full spot and full flood positions. Subsequent tests in another laboratory using a different beam-measuring system produced nearly identical results.

With our photometric methods established, we set about life and beam lumen maintenance tests. In our life tests, we tried to duplicate service conditions as closely as possible. All lamps were tested at rated voltage on direct current in 10,000-w studio spotlights aimed 45° below the horizontal. The lamps were burned for 16-hr intervals in the life-test spotlights, then removed for measurement of relative beam lumens with the photometric hemisphere. The bulb interiors were then cleaned with tungsten powder, and the lamps were returned to the beam photometer, then replaced in the life-test spotlights for another 16-hr burning interval. In order to insure repeatability of results, two seasoned and rated 10,000-w lamps were selected to calibrate the photometric assembly at the beginning of each series of beam readings. These lamps, burned only during photometric testing, provided a guarantee of consistent comparisons over several months of testing.

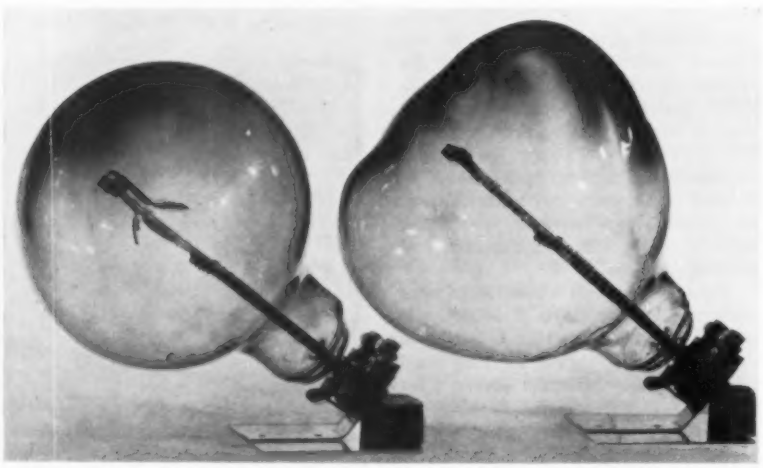


Fig. 6. Left, lamp with collector grid at end of life; right, lamp without grid.

Fig. 7. Beam lumen maintenance of 10,000-w lamps in a typical spotlight.

The New 10,000-w Lamp

This relatively complex development and testing program culminated in a new lamp design incorporating a collector grid. The tungsten-wire screen is fastened to supports and electrically isolated from the filament (Fig. 4). In operation, the screen is located between the filament and the mirror, so that it is above the filament when the spotlight is aimed down. The total lamp lumens from the new design are slightly less, but the important factor, beam lumens, remains almost exactly the same. Testing of a studio spotlight on a goniometer over a projection distance of 50 ft indicates that beam patterns are essentially identical in all focus positions for new lamps with and without collector grids. Typical candlepower distribution data are shown in Fig. 5. The grid does not alter the beam because it is about 80% transparent, and it occludes only a small area of the spotlight mirror.

The most significant improvements in the new lamp are its reduced blistering and its improved beam lumen maintenance characteristics. As shown in Fig. 6, a typical collector-grid lamp burned in a spotlight to the end of filament life at 45° from base down has barely noticeable blistering. This suggests that the effective life of the lamp in spotlight service will go from the 40- to 50-hr limit now imposed by blistering to nearly the full design life of the filament, approximately 75 hr. Pre-burnout lamp replacement may still be desirable in order to avoid delays caused by a burnout during filming. Beam lumen maintenance for lamps with and without grids is shown in Fig. 7. Comparing total useful light — that is, beam-lumen-hours — from lamps with and without collector grids gives a measure of the added value provided by the grid. If we assume that the nongrid lamp is useful for about 50 hours of spotlight service, and that the collector-grid lamp is removed before burnout at 60 hours — a 20% life increase — the total beam-lumen-hour increase provided by the grid is about 37%. If the collector-grid lamp is burned to failure — at about 75 hours — then it will deliver about 68% more beam-lumen-hours than the non-grid lamp will in 50 hr of spotlight service.

Another feature has been added to the new 10,000-w lamp that improves its shipping and handling characteristics. The mogul bipost base construction (Fig. 8) supports the entire filament mount structure in two copper posts which are sealed into the glass base. Rough handling of the lamp in shipment can cause the weight of the filament and supporting structure to distort the cups at their shoulders, moving the filament off-center in the bulb. In extreme cases, distortion may move the filament enough closer to the bulb wall to affect bulb temperature. Usually, this filament distortion in shipment can be corrected easily and safely by placing the lamp in an unwired socket or similar holder and gently moving the bulb until the filament is centered. In the new 10,000-w lamp, however, two small mount braces are added to the bipost cup assembly. Extensive shipping tests indicate that these braces will minimize mount distortion caused by rough handling; hence, less time will be lost in occasionally recentering filaments.

Extension of Collector-Grids to Other Sizes

The remarkable improvements that the collector grids made in performance of 10,000-w lamps immediately suggested extension of the design to other sizes. Life and beam-lumen tests similar to those described above were made with 5000-w lamps in both the G-64 and T-64 bulbs. As expected, the collector-grid reduced blackening and blistering in the G-64 bulb. In the T-64, the improvement was barely apparent. Beam-depreciation characteristics of 5000-w spotlights make it apparent that the collector grid gives only a minor improvement over the standard lamp with the T-64 bulb. This improvement is not at all in proportion to the increased costs that inclusion of the grid would impose. Another conclusion that can be drawn from our testing is that users of G-64 lamps can gain about 10% in light over lamp life with an equivalent lamp cost

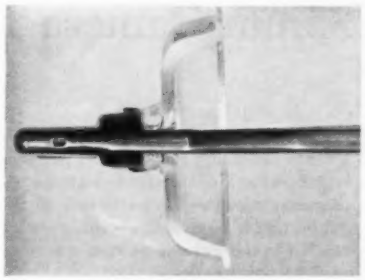


Fig. 8. Cutaway of bipost base cup.

increase by switching to T-64 lamps. This means that users will be able to get more light, on the average, with fewer spotlights by employing T-64 lamps.

Our tests indicate that, at the present time, conditions do not warrant the extension of the collector grid design to the 5000- and 2000-w studio lamps.

Conclusions

The recent studies made on high-wattage studio spotlight lamps have produced important results: (1) A vastly improved 10,000-w spotlight lamp is now available that holds the promise of significantly reducing production costs through its greater spotlight service life and its better beam-lumen-maintenance characteristics. (2) Comprehensive tests have confirmed that the T-48 and T-64 bulbs provide more light through life than corresponding G-bulbs for users of 2000- and 5000-w lamps. (3) During our tests, considerable emphasis was placed on the value of frequent lamp cleaning with tungsten powder as a means of further improving lighting results. (4) Low-noise construction features have been brought to the studio lamps most commonly used on alternating current in television and some motion-picture studios.

Acknowledgment

We would like to express our thanks to D. W. Prideaux, Motion-Picture Studio Engineer for the General Electric Lamp Division, for keeping our laboratory informed on the lighting needs of the motion-picture industry. His interest in, and intimate knowledge of, the subject has been a constant help to the lamp design engineers. To the several others who have aided in this development by suggestions and by furnishing test information, we would also like to express thanks.

35mm Camera Lenses

By GORDON HENRY COOK

An earlier paper (March 1956 Journal) discussed the optical problems to be overcome in providing a standard of performance which is adequate for subsequent enlargement at a considerable scale on large viewing screens in the theater. Certain characteristics have hitherto limited the performance of conventional lenses. The application of new design techniques together with the use of new optical materials has led to the development of a new and complete range of camera lenses to suit modern requirements.

A FEW YEARS AGO the trend towards larger and wider theater screens presented new problems to lens manufacturers. One of the factors was the increased magnification between the scale of negative image detail and that of the picture on the screen. This emphasized the fact that no camera lens is perfect and that some improvements were urgently required.(*)

Detailed explanations of the difficulties to be overcome are outside the scope of this paper but it is possible to describe the main limitations to lens performance which have existed until very recently and to show how these have been significantly reduced. It can be assumed that the reduction of the particular limitations described presents no additional difficulty in holding other aspects of lens performance at the desired level.

The magnitude of the aberrations present in camera lenses is sufficient to justify the use of purely geometrical concepts of image formation. Figure 1 shows an oblique pencil of light traced through a meridional section of a typical camera lens. Rays of light from a very distant point object enter the lens at the left and converge to intersect the focal plane at the right. If the lens were perfect, all the rays in the pencil would converge to meet in the focal plane as a true point image.

The figure also shows that the clear apertures at the front and rear of the lens set a limit to the width of the oblique beam that the lens can transmit and that the effective relative aperture of the lens reduces with increasing angular field of view. The construction lines on the diagram show how the width of the oblique pencil is related to the aperture of the lens for rays passing parallel to its axis. The circles drawn as broken lines represent the diameter of the axial front and rear apertures of the lens. Viewed obliquely, as though through a hollow cylinder, the two circles are displaced relative to one another and the overlapping area common to both is a measure of the aperture of the lens for an oblique pencil at the particular angular field of view.

The graph at bottom right in the figure indicates the conventional way in which a diagram can be prepared to show simultaneously the state of aberration correction in the pencil and the size of its meridional aperture. A number of rays in the pencil are traced through the system at different spacings from a principal ray passing through the center of the iris diaphragm. For each ray spacing there is a corresponding point on the vertical scale of the diagram so that the full vertical extent of the diagram is a direct measure of the width of beam that the lens can transmit. Comparison with a similar diagram for an axial beam gives an indirect assessment of the amount of vignetting present at the field position under consideration.

In the absence of aberration every ray in the pencil would intersect the focal plane at the intersection point of the principal ray to form a true point image of a point object. The effects of aberration are to displace the intersection point of each ray away from this ideal position and the displacements for each ray are plotted on an exaggerated scale in the horizontal direction at the appropriate position on the ordinate of the diagram. Displacements in the focal plane away from the axis are positive and to the right in the diagram, and displacements towards the axis are negative and to the left. A smooth curve drawn through all the points plotted in this way gives complete information concerning the degree of correction present. Horizontal departures of the curve from the vertical ordinate are a measure of the aberration present and of the finite size of the patch of light which constitutes the image of a point object.

Figure 2 shows these conventional aberration diagrams for four positions in the field of view of a typical camera lens which has been used extensively for a number of years. It will be seen that, although aberrations in the center of the picture area are reasonably well corrected, their magnitude increases very rapidly with increased angular field. The pronounced reduction in the extent of the vertical scale at the wider angular field positions indicates that vignetting is very severe in this lens and, in fact, the magnitudes of off-axis aberrations are only held to barely acceptable levels by the vignetting of oblique beams of light. The degree of vignetting indicated is too severe for correct exposure in color photography especially when the lens is used within one or two stops

Presented on April 21, 1958, at the Society's Convention in Los Angeles by Petro Vlahos for the author, Gordon Henry Cook, Taylor, Taylor & Hobson Ltd., Stoughton St., Leicester, Eng. (This paper was received on April 16, 1958.)

* G. H. Cook, "Modern cine camera lenses," *Jour. SMPTE, 65:* 155–161, Mar. 1956.

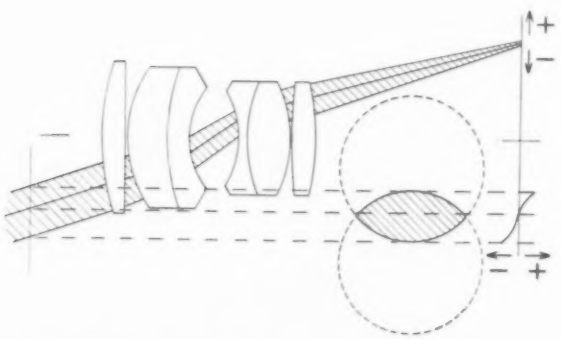


Fig. 1. Typical vignetting and aberration.

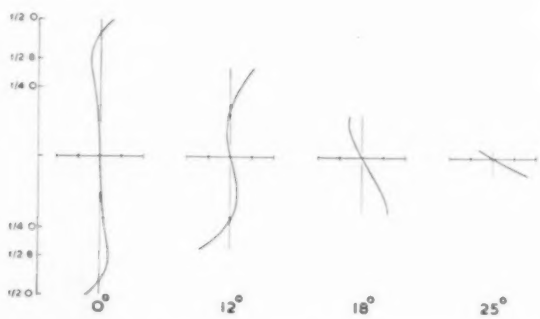


Fig. 2. Lens A, 32mm f/2.0; meridional aberration in focal plane. First type of compromise between vignetting and definition.

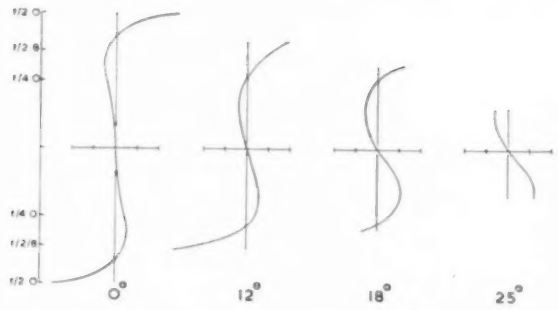


Fig. 3. Lens B, 32mm f/2.0; meridional aberration in focal plane. Second type of compromise between vignetting and definition.

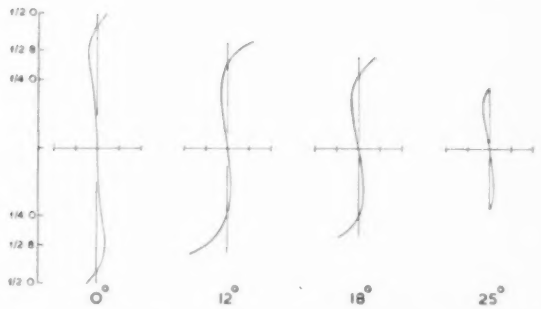


Fig. 4. Lens C, 32mm f/2.0; meridional aberration in focal plane. Simultaneous improvements in vignetting and definition obtainable with new lens construction.

from full aperture when covering the larger silent or CinemaScope gate aperture.

Figure 3 shows the same type of aberration diagrams for a lens of similar construction in which an attempt was made to reduce the rate of change of aberration across the field of view so that the aperture of oblique beams could be increased with the minimum loss of definition. In comparison with Fig. 2 it is clear that some appreciable sacrifice of definition was unavoidable, particularly on axis and in the intermediate areas of the negative.

For a number of years Figs. 2 and 3 could have indicated the extent of the lens designer's freedom of action. In general, an improvement of both image illumination and definition towards the corners of the picture format could only be achieved by sacrificing performance in the more important areas around the center.

It should be realized that scaling the dimensions of a lens construction to increase its focal length also results in a proportional increase in the magnitude of its aberrations. Thus Figs. 2 and 3 not only show the variations that were possible at one focal length but also indicate the possibility and desirability of designing each lens in a range of focal lengths to cover its own particular angular field to maintain a common standard of performance throughout the range.

In recent years more efficient methods of lens design based on the use of electronic computors, together with the availability of new and extreme types of optical glass, have yielded lens constructions in which these basic limitations have been significantly reduced.

Figure 4 shows the resultant improvements provided by a new commercially available lens construction. The change of aberration across the field of view is almost completely removed and the magnitude of the residual aberrations at any point is much smaller than hitherto. Vignetting of oblique beams is held to an acceptable level without the introduction of objectionable loss of definition. In this way the new lens has an axial performance at least equal to the best obtainable with the older lenses and in its field of view it is superior for both definition and uniformity of image illumination.

Figure 5 is a sectional drawing of the new lens construction. Contrary to the usual design procedures in which the use of higher refractive index glasses merely permits shallower curvatures on the lens components, this design achieves higher standards of performance in other ways. In comparison with the older type lenses shown in Fig. 1, the thicknesses of the inner doublet components are considerably reduced and there is a different relationship between the central air space and the curvature of the two innermost surfaces. These differences make a large contribution towards the reduction of the fundamental limitation that has been described and it is of interest to note that they would be quite valueless in the absence of the new optical glasses. The use of two simple components at the rear of the lens instead of the usual single component provides the extra variables which help maintain a good balance of aberration throughout the field of view.

Nevertheless, the new lens still bears a strong family likeness to the older lenses so that the type of variation depicted in Figs. 2 and 3 can still be applied. In this way, the adoption of the best compromise between axial performance and the angular field to be covered compensates for the effects on aberration of scaling-up the focal length and permits performance to be maintained at the new high level throughout a useful range of focal lengths.

Although the extent of the range of focal lengths that can be accommodated in this way is no less than in the older lenses, there remain other optical and mechanical difficulties to be overcome if all modern lens requirements are to be fulfilled.

Trends towards wider angle photography place an increasing degree of importance on the short focal length

Fig. 5. Optical construction of new 32mm f/2.0 Cooke Speed Panchro Series II.

end of the range. For semiangular fields of view in excess of about 25°, even the improvements previously described are incapable of providing an acceptable standard for both uniformity of image illumination and definition. Further difficulties arise in fitting short focal length lenses to some types of cameras where mechanisms in front of the gate demand a relatively large clearance between the rear of the lens and the plane of the film.

Some of these difficulties were overcome as long ago as 1930 by the use of cinematographic lenses based on inverted telephoto principles but only recently has it been possible to offer such lenses yielding standards of definition in keeping with the quality of more normal types. These improvements are so pronounced that inverted telephoto lens constructions can now be recommended for use even when the camera does not demand a large clearance behind the lens.

The fundamental characteristics of inverted telephoto lenses are shown in Fig. 6 in which the top diagram in-

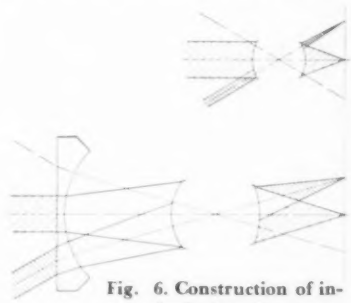


Fig. 6. Construction of inverted telephoto lenses.

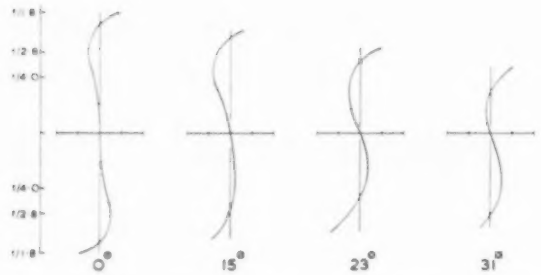


Fig. 7. Cooke Speed Panchro Series II 25mm f/1.8; meridional aberration in focal plane.

dicates the external glass surfaces of a normal type of lens and the widths of the axial and oblique beams that can be transmitted again show the vignetting limitations of this type of construction. The bottom diagram shows an inverted telephoto lens of the same focal length, relative aperture and angular field of view. Its rear collective component is at an increased distance from the film plane so as to yield the necessary increased clearance at the rear and to reduce the obliquity of beams of light forming off-axis images. The front dispersive component is large enough in diameter to accommodate the increased width of oblique beam that can be transmitted through the rear component. The diagram shows the increased oblique aperture of this type of lens and also that its viewpoint is extended forward from the conventional position. This more forward viewpoint is often advantageous in avoiding obstruction to image-forming beams of light caused by other longer focal length lenses on the camera turret.

If the front dispersive and rear collective components of inverted telephoto lenses are made sufficiently complex in construction, the designer has sufficient variables at his command with which to control all aberrations to the level demanded by the new standards of performance now being offered.

The aberration diagrams shown in Fig. 7 are representative of the type of performance now possible with inverted telephoto lenses. The uniformity of image illumination across the field of view is unusually high right out to the corners of the picture format whilst aberrations are stable and small in magnitude.

In the range of long focal length and telephoto camera lenses, similar advantages to be gained from new lens construction and design procedures result in improvements of equal significance. New standards of performance are therefore available for all applications of 35mm cinematography and similar improvements can be realized in lenses intended for use with other professional sizes of negative format.

Acknowledgment

Thanks are due to Taylor, Taylor & Hobson Ltd. for permission to publish this paper.

motion-picture standards

Published here are American Standards PH22.23-, PH22.109-, and PH22.110-1958, which were approved by the American Standards Association on June 26, 1958.

PH22.23–1958, 8mm Motion-Picture Projection Reels, is a revision of Z22.23-1941. The final version remains the same as that published for trial and comment in the September 1957 Journal.

PH22.109–1958, Dimensions for 16mm Motion-Picture Film, 1R-2994 and PH22.110–1958. Dimensions for 16mm Motion-Picture Film, 2R-2994, had their trial publication in the January 1957 Journal. During publication, comments were received concerning paragraph 2.3 and the proposals were returned to the initiating committee for resolution of the objections raised. As a result, modifications of both standards were approved and are incorporated in these final drafts. The changes involve the deletion of paragraph 2.3, addition of Appendix 5, correction of the millimeter conversion of Dimension L and addition of tolerances to Dimension R.—*J. Howard Schumacher*, Staff Engineer.

American Standard

8mm Motion-Picture Projection Reels

ASA
Reg. U.S. Pat. Off.
PH22.23-1958
Revision of
Z22.23-1941
*UDC 778.55

1. Scope

1.1 This standard specifies the dimensions for 8mm motion-picture projection reels having film capacities of 200, 400, 600 or 800 ft.

1.2 The note is a part of the standard.

2. Dimensions

2.1 The dimensions shall be as specified in the diagram and tables.

2.2 Dimension C shall be measured between the inside faces of the two reel flanges. If spring fingers are used to engage the edges of the film, dimension C shall be measured with the fingers fully expanded.

2.3 The measurement of dimension G shall include any embossing.

2.4 Dimension H shall be measured at the core and shall include rivets, lugs and any other protrusions.

2.5 Dimension J shall apply within a circle of radius ½ in. (12.7mm) or more, centered on the spindle-hole axis.

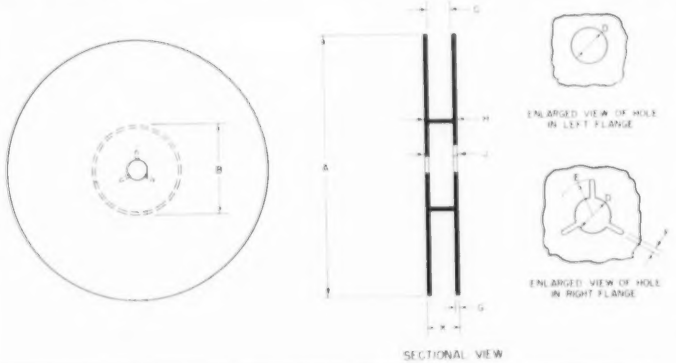
2.6 Dimension K shall be measured at the periphery of the reel.

2.7 The maximum flange and core eccentricity shall be 0.010 in. (0.25mm). The total maximum deviation may be 0.020 in. (0.51mm), measured from the spindle-hole centerline.

2.8 Lateral runout, dimension L, is the maximum departure of any point on a flange of the reel from the *intended* plane of rotation of that point, when the reel is rotated on an accurate and tightly fitted shaft. This departure can be in either direction from the plane; therefore, the total excursion can be twice the numerical value shown.

NOTE

The drive side of the reel shall have one or more keyways, but preferably an odd number. There shall be no driving keyways in the other side of the reel.



Approved June 26, 1958, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

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70 East Forty-fifth Street, New York 17, N. Y.

Printed in U.S.A.
ASA\M858

Price, 25 Cents

TABLE 1

Capacity of Reel			Inches		Millimeters	
Feet	Meters	Dimension	Max	Min	Max	Min
200	61	A	5.031	5.000	127.79	127.00
		B	2.000	1.500	50.80	38.10
		L	0.057		1.45	
400	122	A	7.031	7.000	178.59	177.80
		B	2.500	1.500	63.50	38.10
		L	0.080		2.03	
*600	183	A	9.031	9.000	229.39	228.60
		B	3.531	3.469	89.69	88.11
		L	0.103		2.62	
*800	244	A	10.531	10.500	267.49	266.70
		B	4.906	4.844	124.61	123.04
		L	0.120		3.05	

*See Appendix f

TABLE 2

Dimension	Inches	Millimeters
C	0.350 ± 0.030	8.89 ± 0.76
D	0.319 Max	8.10 Max
	0.316 Min	8.03 Min
E	0.312 ± 0.005	7.93 ± 0.13
F	0.070 Max	1.78 Max
	0.060 Min	1.52 Min
G	0.091 Max	2.31 Max
	0.025 Min	0.64 Min
H	0.562 Max	14.28 Max
J	0.450 Max	11.43 Max
K	0.562 Max	14.28 Max

APPENDIX

(This Appendix is not a part of American Standard 8mm Motion-Picture Projection Reels, PH22.23-1958, but is intended to facilitate its use.)

a. Dimension D was chosen to give sufficient clearance between the reels and the largest spindles normally used on 8mm projectors.

b. The nominal value of C was chosen to provide proper lateral clearance for the film. The channel is narrow enough to prevent the film from wandering laterally too much as it is coiled, a condition which causes loose winding and excessively large rolls.

c. It is recommended that the driven flange have at least three driving slots so that it will not be necessary to turn the reel more than 120 degrees in order to engage it with the driving key of the spindle. An odd number of slots is suggested so that the keyway cannot come into alignment with the spring that normally latches the reel on the spindle and thus allow the reel to move along the spindle.

d. When the ratio of reel flange diameter (A) to core diameter (B) is small, there tends to be less variation in the tension to which film is subjected by the take-up mechanism throughout the projection of a roll of film. This is particularly true if a constant torque device is used. In this standard, the outside diameters of the flanges (A) were made as large as practicable commensurate with past practice in the design of projectors, reel containers, rewind units, and similar equipment. This made it possible to specify relatively large cores (which are desirable) and to attain reasonably small flange-to-core ratios.

e. For 200 and 400-ft reels, rather large tolerances are given for B in order to include reels of current manufacture which have given reasonably satisfactory service. When new reels are designed, or when present reels are re-tooled, the cores for the 200 and 400-ft reels should be made in accordance with the maximum values shown in the table. If this is done, it may be possible to have future issues of this standard show tolerances on core diameter similar to those specified for 600 and 800-ft reels.

f. 600-ft and 800-ft reels are not in use at this time. The specifications are provided so that a standard will be available should these reels come into use.

American Standard

Dimensions for 16mm Motion-Picture Film, 1R-2994

ASA
Reg. U.S. Pat. Off.
PH22.109-1958
SUDC 771.531.1/3.531.7

1. Scope

1.1 This standard specifies the cutting and perforating dimensions of 16mm motion-picture film with perforations along one edge.

1.2 These dimensions pertain to a safety film with low-shrinkage characteristics as defined in Appendix 1.

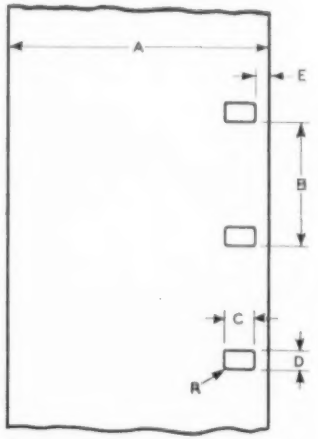
1.3 The notes are a part of the standard.

2. Dimensions

2.1 The dimensions shall be as given in the diagram and table.

2.2 These dimensions apply to raw stock immediately after cutting and perforating.

2.3 Dimension L represents the length of any 100 consecutive perforation intervals.



Dimensions	Inches	Millimeters
A	0.628 ± 0.001	15.95 ± 0.03
B	0.2994 ± 0.0005	7.605 ± 0.013
C	0.0720 ± 0.0004	1.829 ± 0.010
D	0.0500 ± 0.0004	1.270 ± 0.010
E	0.0355 ± 0.0020	0.902 ± 0.051
L	29.94 ± 0.03	760.5 ± 0.8
R	0.010 ± 0.001	0.25 ± 0.03

Approved June 26, 1958, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers
*Universal Decimal Classification

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ASA/M858

Price, 25 Cents

NOTES

1. The dimensions in the inch system are the fundamental standard. The dimensions in the metric system are practical approximations based on American Standard B48.1-1933, reaffirmed in 1947, providing a conversion factor of 1 inch = 25.4 millimeters.

2. The title of this standard was established by the application of a nomenclature system developed for all film dimension standards: Each title provides an indication of the film width, the perforation pitch (without the decimal point) and the perforation shape (BH, KS, DH or CS) or number of rows of perforations (1R, 2R or 4R), depending on which is the significant factor.

3. This standard differs from American Standard Dimensions for 16mm Film, Perforated One Edge, PH22.12-1953, primarily in the values for dimensions A, B and L which are specified there respectively as 0.629 ± 0.001 in., 0.3000 ± 0.0005 in. and 30.00 ± 0.03 in. (See Appendices 2 and 4.)

APPENDICES

(These Appendices are not a part of American Standard Dimensions for 16mm Motion Picture Film, 1R-2994, PH22.109-1958, but are included to facilitate its use.)

APPENDIX 1

For the purpose of this specification, low-shrink film base is film base which, when coated with emulsion and any other normal coating treatment, perforated, kept in the manufacturer's sealed container for six months, exposed, processed and stored exposed to air having a temperature of 65 F to 75 F, 18 C to 24 C, and a relative humidity of 50% to 60%, for not more than 30 days, and measured under like conditions of temperature and humidity, shall have shrunk not more than 0.2% from its original dimension at the time of perforating.

APPENDIX 2

Experience shows that it is common for film to expand when exposed to high relative humidity. Allowance should be made for this factor in equipment design and in no case should the equipment design fail to accommodate a film width of 16mm, 0.630 in.

APPENDIX 3

To comply with 1.2, this film is made on safety base complying with American Standard Specifications for Safety Photographic Film, PH1.25-1956.

APPENDIX 4

Films which after processing are intended to pass through a continuous contact printer in which the exposure is made over a cylindrical surface do not yield prints of maximum steadiness unless the actual pitch of the film curved to the smaller radius (the "negative") is slightly less than that of the film curved to the larger radius (the "print stock"). Since positive films in general are perforated to a nominal 0.3000 in. pitch and since negative-type films with low-shrinkage characteristics do not shrink enough for optimum pitch relationship with such positive films, the nominal 0.2994 in. pitch was developed for films to be used primarily as negatives for the subsequent production of prints. They also find other specialized uses.

APPENDIX 5

The uniformity of pitch, margin and hole size (Dimensions B, C, D, and E) is an important variable affecting steadiness. Variations in these dimensions, from roll to roll, are of little significance compared to variations from one sprocket hole to the next. Actually it is the maximum variation from one sprocket hole to the next within any small group of consecutive perforations that is important.

American Standard

Dimensions for 16mm Motion-Picture Film, 2R-2994

ASA
Reg. U.S. Pat. Off.
PH22.110-1958

1. Scope

1.1 This standard specifies the cutting and perforating dimensions of 16mm motion-picture film with perforations along two edges.

1.2 These dimensions pertain to a safety film with low-shrinkage characteristics as defined in Appendix 1.

1.3 The notes are a part of the standard.

2. Dimensions

2.1 The dimensions shall be as given in the diagram and table.

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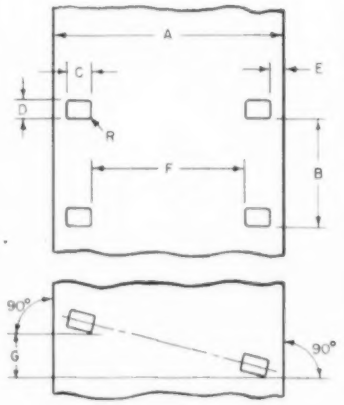
2.3 Dimension L represents the length of any 100 consecutive perforation intervals.



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C	0.0720 ± 0.0004	1.829 ± 0.010
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E	0.0355 ± 0.0020	0.902 ± 0.051
F	0.413 ± 0.001	10.49 ± 0.03
G	0.001 max	0.025 max
L	29.94 ± 0.03	760.5 ± 0.8
R	0.010 ± 0.001	0.25 ± 0.03

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2. The title of this standard was established by the application of a nomenclature system developed for all film dimension standards. Each title provides an indication of the film width, the perforation pitch (without the decimal point) and the perforation shape (BH, KS, DH or CS) or number of rows of perforations (1R, 2R or 4R), depending on which is the significant factor.

3. This standard differs from American Standard Dimensions for 16mm Film, Perforated Two Edges, PH22.5-1953, primarily in the values for dimensions A, B and L which are specified there respectively as 0.629 ± 0.001 in., 0.3000 ± 0.0005 in. and 30.00 ± 0.03 in. (See Appendices 2 and 4.)

APPENDICES

(These Appendices are not a part of American Standard Dimensions for 16mm Motion-Picture Film, 2R-2994, PH22.110-1958, but are included to facilitate its use.)

APPENDIX 1

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APPENDIX 2

Experience shows that it is common for film to expand when exposed to high relative humidity. Allowance should be made for this factor in equipment design and in no case should the equipment design fail to accommodate a film width of 16mm, 0.630 in.

APPENDIX 3

To comply with 1.2, this film is made on safety base complying with American Standard Specifications for Safety Photographic Film, PH1.25-1956.

APPENDIX 4

Films which after processing are intended to pass through a continuous contact printer in which the exposure is made over a cylindrical surface do not yield prints of maximum steadiness unless the actual pitch of the film curved to the smaller radius (the "negative") is slightly less than that of the film curved to the larger radius (the "print stock"). Since positive films in general are perforated to a nominal 0.3000 in. pitch and since negative-type films with low-shrinkage characteristics do not shrink enough for optimum pitch relationship with such positive films, the nominal 0.2994 in. pitch was developed for films to be used primarily as negatives for the subsequent production of prints. They also find other specialized uses.

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news and reports

84th Semiannual Convention, October 20–24, Detroit

Topic Chairmen have been actively assisting in the accumulation of papers, according to Program Chairman C. E. Heppberger. The latest addition reported in detail by Hepp is a symposium on 16mm color internegative/positive which should stir up a lot of interest in the heavily concentrated area of 16mm film activity adjacent to Detroit.

Part I — Laboratory Methods of Use

"Preparation of Originals," by Robert A. Colburn, Geo. W. Colburn Laboratory, Inc., Chicago.

"Printing Procedures and Controls," by John R. Stillings, Lakeside Laboratory, Gary, Ind.

"Processing Procedures and Controls," by William D. Hedden, The Calvin Co., Kansas City, Mo.

Part II — New Equipment Designed for Its Use

"Two New 16mm Printers," by Geo. W. Colburn, Geo. W. Colburn Laboratory, Inc., Chicago.

"Equipment for Printing 16mm Color Internegative and Color Positive," by R. Paul Ireland, EDL Co., Gary, Ind.

"The Colormatic Printer," by Lloyd Thompson and Kenneth B. Curtis, The Calvin Co., Kansas City, Mo.

Besides this new group, the following papers are already on hand and are a sufficient indication of the variety of aspects covered in connection with the central theme of the program — *Films and Television in Industry and Education*:

The Bell & Howell Additive Color Printer
An Automatic Shutter Control for the D& J Printer
New Eidophor System for Large-Screen Projection of TV
Projection Noise Levels
Improved Vidicon Focusing and Deflecting Coils
The Marconi 16mm Fast Pulldown Kinescope Recorder
The "Sun Calculator" — A Method of Predetermining the Approximate Compass Position of the Sun During the Day
Operations Research on Instructional Films
On the Quality of Color Television Images and the Perception of Color Detail
Emulsion Sensitivity for the Photography of Cathode-Ray Tubes
Catching Bank Robbers With Cameras
Versatility, the Theme of Percepto-Scope Design
Color and Monochrome Closed-Circuit Television at a Large University
Television Zoom Lenses
Automatic Printed Character Reading
Closed-Circuit Television in Hagerstown, Md.
An Improved Tear Detector for Film Processing Machines
The TV Workshop: a Unique J. Walter Thompson Client Service
Analysis of Growing Business Film Usage
A Technique for Reducing Contrast for Special Purposes in Printing From Negatives of Normal or Excessive Contrast
Laboratory Problems and Procedures in Processing Color Negative in the Cinemiracle Process and Preparation of Theater Prints Therefrom
Photographic Processing Equipment
Administrative-Operational Problems of Medical Color Television

Equipment Exhibit

Exhibit Chairman Ray Balousek reports that booths are fast being taken for what promises to be a most active and interesting show. Situated between the registration area and the sessions auditorium, the Exhibit is likely to be the focal center of activity during the Convention and the concentration of new and important professional equipment from the U.S. and Canada will undoubtedly attract many from the Detroit area.

Arrangements are now in full swing for the distribution of booth space. Among those companies who have already been definitely assigned to booths are:

Animation Equipment Corp.
Bell & Howell Co.
Andre Debrie Mfg. Corp.
Electronic Systems of Illinois, Inc.
Florman & Babb, Inc.
Karl Heitz, Inc.
Kling Photo Corp.
Lipsner-Smith Corp.
Macbeth Instrument Corp.
Neumade Products Corp.
Precision Laboratories
S.O.S. Cinema Supply Corp.
Westrex Corp.

Last-minute inquiries about space should be addressed to Ray Balousek, Exhibit Chairman, c/o Producers Color Service, 24 Custer, Detroit 2, Mich. Consult the floor plan on p. 543 of this issue, but be sure to give several alternative booth preferences, since there are very few booths left.

Nominations for Society Offices and Annual Awards

The roster prepared by the Nominating Committee and approved by the Board of Governors at its meeting July 11, 1958, is: President, Norwood L. Simmons; Executive Vice-President, John W. Servies; Editorial Vice-President, Glenn E. Matthews; Convention Vice-President, Reid H. Ray; Secretary, Wilton R. Holm. Nominees for Governor are: (Atlantic Coast) Gerald G. Graham, A. L. Hammerschmidt, Robert C. Rheineck and Richard E. Warn; (Central Area) W. Wallace Lozier, Kenneth M. Mason, Lloyd Thompson and James L. Wassell; (Pacific Coast) Theodore B. Grenier, R. A. Isberg, Ub Iwerks and Edwin W. Templin.

The nominations for the Society's annual awards are being announced late this month and will be reported in the September *Journal*. Presentations will be made at the Detroit Convention, Oct. 20–24.

The following members are nominated for advancement to the rank of Fellow (John G. Frayne, Chairman): Waldon S. Ball, Philip M. Cowett, Raymond B. Dull, Linwood G. Dunn, Charles P. Ginsburg, Theodore B. Grenier, Louis Hagemeyer, Carl W. Hauge, S. E. Howse, Keith B. Lewis, David L. MacAdam, Herbert W. Pangborn, Burton F. Perry, Douglas Shearer, Charles S. Stodter.

The Directory for Members will, in the future, be published biennially, rather than annually as has been the recent custom, according to a resolution adopted July 11, 1958, by the Board of Governors. This means that the next Directory for Members is scheduled for April 1960. In order to supply members and subscribers with up-to-date membership information, a list of new members will be published quarterly in the *Journal*. Information to be published annually includes listings of Administrative and Engineering Committees, Officers, Governors and Managers and Awards, and Financial Statements.

4th High-Speed Congress

The Program for the 4th International Congress on High-Speed Photography in Cologne, Sept. 22–26, has been received at Society Headquarters and is presently available upon request. The elegantly designed pamphlet contains the papers, demonstrations and films in eight sessions and also specifies times and meeting places for social events and excursions. Earlier announcements for this Congress appeared in the *Journal* for April 1958 on p. 264 and June 1958 on p. 416.

The United States is represented in the Program by eight papers. One author, H. E. Edgerton of the Massachusetts Institute of Technology, will present two papers, "Examples on High-Speed Photography" and "A Short-Duration Source and Examples of the Use." The other U.S. papers are: "Optical Considerations in the Development of a Direct Access Photomemory" by R. H. Kay, IBM Research Laboratory, San Jose, Calif.; "Pin Hole Camera in Missile Records Roll and Yaw Orientation, Spacial Position and Surface Pressure" by W. Allan and D. B. Clark, Naval Ordnance Test Station, China Lake, Calif.; "Application of Rotating Mirror Principle to a New Medium Framing Rate Camera" by J. R.

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Greer, Beckman and Whitley Inc., San Carlos, Calif.; "Presentation of an Underwater Explosion Film" by S. J. Jacobs, Naval Ordnance Laboratory, White Oak, Silver Spring, Md.; "High-Speed Photographic Recording of Strong Shocks in Opaque Solids" by M. Sultanoff, Aberdeen Proving Ground, Md.; and "Photography of Burning Strands of a Solid Propellant" by R. B. Bowersox, Jet Propulsion Laboratory, Pasadena, Calif.

An item of interest relevant to the Congress concerns the formation in England of a Committee on High-Speed Techniques Using Optics. Secretary of the Committee is Kenneth R. Coleman, Building D 3, Atomic Weapons Research Establishment, Aldermaston, Berks. Meetings are held quarterly. Four members of the Committee plan to attend the 4th Congress.

Education, Industry News

A total of 11,742 students was graduated from 202 technical institutes in the United States in 1956 in engineering-related curricula. Total enrollment in engineering subjects was 32,498 full-time students and 25,124 part-time. These figures are contained in a report on a survey of technical institutes conducted by the American Society for Engineering Education and the U.S. Office of Education. The term "technical institutes" is defined in the report as "institutions of higher education with programs of less than four years' duration." This report is the first of an annual series planned "to show developments and trends with important manpower implications."

Eight scientific motion pictures produced by the Argonne National Laboratory, Lemont, Ill., are among the 45 films accepted by the U.S. Atomic Energy Commission and the Office for International Conference for presentation at the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland, Sept. 1–13. Titles of the films are: Fast Reactor Program; Experimental Boiling Water Reactor; Experimental Breeder Reactor I Core Disassembly After Meltdown; Experimental Breeder Reactor II Fuel Cycle Development; Experimental Breeder Reactor I Mark III Core; Zero Power Reactor III; Argonaut; and Ionizing Radiation in Man. The films, which were written and produced by George W. Lindholm, Jr., will be prepared in English, French, Spanish and Russian. After the conference they will be available in these languages commercially or through a loan arrangement.

Two experimental films, *New York, New York,* by Francis Thompson, and *A Day in Town,* which was made in Sweden by B. Hulten, have been chosen to receive the Award of Exceptional Merit bestowed by the Creative Film Foundation, 35 Morton St., New York 14, for creative achievement in avant-garde productions. A Special Citation has been awarded to the film *Round and Square,* a joint production of a student film group at Wayne State University under the faculty sponsorship of William Rudy. A variety of experimental techniques and styles are considered in selecting prize-winning films. *New York, New York* uses distorting lenses and multiple images. The Swedish film is a comedy employing some of the techniques of Mack Sennet comedies. The Foundation also presents an Award of Distinction. Films receiving this award are *Who, What, How* by A. Vanderbeek of New York; *An Diesen Abenden* by Herbert Vesely of Germany, and *The Big O* by Carmen D'Avino of New York.

The honorary degree of Master of Photography has been awarded by the Professional Photographers of America to John I. Crabtree, retired Kodak research scientist (*Journal* p. 78, Feb. 1957) and to Wesley T. Hanson, Jr., head of the Color Photography Div., Kodak Research Laboratories.

Described as "one of the leading authorities of the world on photographic chemistry," the citation to Mr. Crabtree stated that "many of the advances in general photographic, medical, x-ray and motion-picture film-processing techniques had their beginning in the research undertaken and supervised by this distinguished scientist." Dr. Hanson's award is in recognition of his research work over a 20-year period in problems of color photography. "The results of this work," the citation states, "have had important applications in all varieties of color photographic products for amateur, professional and commercial use, both still pictures and motion pictures." Both men are Fellows of this Society.

A paper on "Rates of Solution of Silver Halide Emulsion Crystals" by Waldemar Vanselow and T. Howard James, of Eastman Kodak Co. was presented at the 32d National Colloid Symposium in Urbana, Ill., June 19. The paper described research leading toward improved photographic developers, including those for fine-grain photographic materials. The paper is scheduled for early publication in the *Journal of Physical Chemistry.*

Robert W. Wagner, Director of Motion-Picture Production at Ohio State University since 1946, has been appointed head of the Cinema Department, Univ. of Southern Calif. Dr. Wagner succeeds Robert O. Hall who has been appointed Program Associate with the Educational Radio and Television Center at Ann Arbor, Mich. Prior to his appointment at Ohio State Univ., Dr. Wagner had been film writer and director for the Office of War Information and motion-picture producer with the Office of Coordination of Inter-American Affairs. He also served as Chief of Information with the Ohio Department of Public Welfare. In 1951 he was awarded the Encyclopedia Brittanica Film Fellowship.

George L. Oakley, most recently Manager of Bell & Howell's Professional Equipment Div., has been appointed Director of Audio-Visual and Professional Sales for Bell & Howell under its policy of increased emphasis on the audio-visual field.

engineering activities

This report is a brief résumé of major topics discussed and projects reviewed during meetings of the Engineering Committees at the Society's 83rd Convention.

Color

Activities of Color Subcommittees were reviewed. Two Subcommittees, Color Sensitometry and Color Cinematography, were dissolved, following a vote of appreciation for excellent reports on *Principles of Color Sensitometry* and *Elements of Color in Professional Motion Pictures,* respectively. These publications were received with interest by the industry and are now widely accepted as standard works.

A proposed American Standard which would supplement PH2.1-1952 by specifying spectral conditions suitable for determining the sensitometric characteristics of photographic sound record on three-component subtractive color film was discussed. Prior to the meeting a letter ballot had been circulated to the Committee members. The results were inconclusive and the proposal was referred back to the Subcommittee on Densitometry of Soundtracks of which Harry P. Brueggemann is Chairman.

Appointment of four new members was requested by the Committee Chairman A. M. Gundelfinger. The proposed appointees have excellent backgrounds in color television which the Chairman felt would be an asset to the Committee in connection with the television requirements peculiar to the Color Committee's activity. The specific scope of activity of the Committee was discussed. In response to a question about possible overlap in the work of the Television and Color Committees, a Subcommittee was appointed under the chairmanship of S. Eric Howse to investigate the areas of activity and to recommend, if necessary, a clarification or revision of the scope of activity of the Color Committee.

Film Dimensions Committee

One of the main topics of discussion concerned a worksheet submitted to members of ISO/TC Working Group A. It was brought out in discussion that the dimensions were the major source of difficulty since the English system is the fundamental standard in the United States, whereas the metric system is the basis of European standardization. The conversion from inches to millimeters results in some slight discrepancies. It was also noted that this worksheet differed from the one submitted at the last meeting of the Committee in that all of the information required in writing a standard, with the exception of notes, was included. The question was raised if it was the intent of the Committee to process all film dimension standards according to the present worksheet. It was agreed that 1953 standards PH22.1, PH22.5, PH22.12 and PH.93

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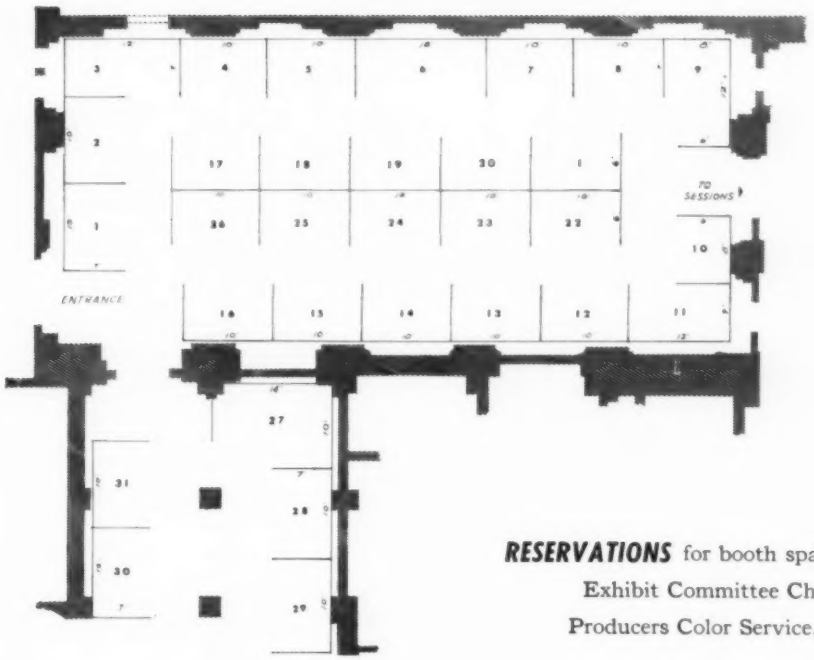

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84TH SMPTE SEMIANNUAL CONVENTION

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be circulated in accordance with the new format. This decision does not affect PH22.109 and PH22.110 as these have been approved by PH22 and are now receiving final consideration by the ASA Committees.

Among other matters discussed was a list of terms, which was submitted to the Committee, describing the letters used in relation to film dimension standards. It was decided to incorporate this list of terms in the table of dimensions.

Film Projection Practice Committee

Following careful discussion and comparison of two 35mm visual test films, one based on a report presented by Walter Beyer at a previous meeting and the other based on the results of the theater survey conducted by the Motion Picture Research Council, it was decided to adopt the MPRC film. The film will have the credit line: "Prepared by the Motion Picture Research Council — Adopted by the Society of Motion Picture and Television Engineers."

Other topics of discussion included: Indiscriminate Placement of Cue Marks; CinemaScope Sprocket Standards; Heat Control at the Aperture Gate; and PH22.4, 35mm Motion-Picture Reels and Spindles.

Various cue-mark placement practices used for anamorphic release prints and wide-screen prints were demonstrated by Mr. Beyer. Research Council Industry Practices No. 30 and 31, dated February 5, 1958, recommending a cue-mark placement that is visible on the screen for all aspect ratios, were reviewed. It was agreed to forward comments of the Committee to the Laboratory Practice Committee for consideration in relation to PH22.55 which is under that Committee's jurisdiction.

A discussion on PH22.4, 35mm Motion-Picture Projection Reels, centered around the overall diameter and hub size dimension for 1000-ft reels. It was questioned whether the diameter should be 11 or 11¼ in. Mr. Beyer offered to make a test with color film with magnetic striping to determine whether the 11- or the 11¼-in. diameter is the more desirable. A fourth draft of the proposal, based on results of the test, will be submitted to the Committee.

The Staff Engineer reported that there had been several requests for a 35mm jump and weave standard. It was agreed to investigate the technical considerations involved in writing such a standard.

High-Speed Photography

Plans for the Fifth International High-Speed Congress, which will be held concurrently with the SMPTE 1960 Fall Convention, were discussed. Participation by military and industry representatives will be invited. It was decided to consult with members of the State Department and, in the near future, to initiate correspondence with possible participants.

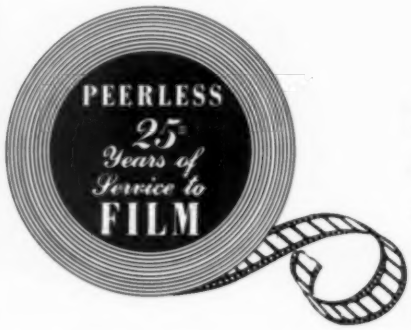
A report was presented by the Subcommittee appointed to propose a revision of the official scope of the activity of the Committee. A definition to be voted upon by Committee members states: "To use all of the resources of the Society to further the art of recording and evaluating information from events which require observations taken at abnormal frame rates (i.e., high-speed or time-lapse) or with short exposure time. Furthermore, the Committee will propose standards and specifications for use with relevant equipment."

A report from the Subcommittee appointed at the last meeting of the Committee (April 1958 *Journal*, p. 264) to explore areas of overlap of activity, particularly in regard to SPSE, indicated that an overlap did exist, but with no specific conflicts at present.

Laboratory Practice

Topics discussed included proposed Standards and revisions which are under consideration by the Committee: PH22.56, Nomenclature for Motion-Picture Film; Z22.55-1947, 2000-ft Release Print Standard; Brightness of Review Room Screens; A&B 35mm Printing; and PH22.27, Method of Determining Transmission Density of Motion-Picture Films. PH22.37, Raw Stock Cores for 35mm Motion-Picture Film, previously under the jurisdiction of the Film Dimensions Committee, has been referred to the Laboratory Practice Committee. F. J. Scobey was appointed Chairman of a Subcommittee to study the Standard and to make recommendations as to its reaffirmation, revision or withdrawal.

Publication of the booklet on **Control in Processing Black-and-White Motion-Picture Films,** which has been approved by the Board of Governors, was discussed. A report from the Subcommittee, of which W. I. Kisner is Chairman-Editor, stated that the schedule called for delivery of the final manuscript to Society headquarters before January 1, 1959, and publication in April 1959.



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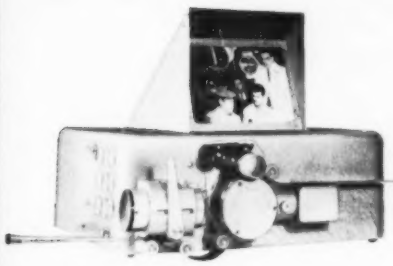

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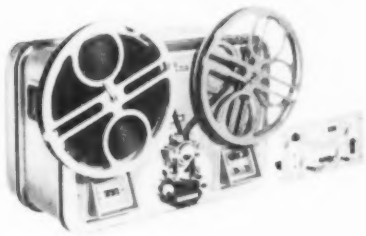

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Motion-Picture Studio Lighting Committee

Topics discussed by the Committee included: (*1*) *Net Transmission Standards:* A subcommittee was appointed to investigate nomenclature. (*2*) *Standardization of Pin Plugs:* It was agreed to ask M-G-M to suggest dimensions for a Standard or recommended practice. (*3*) *Window Filters:* A proposal for a recommended practice specifying transmission characteristics and possible materials for window daylight correction filters for tungsten-balanced film will be circulated to the Committee.

A Subcommittee was appointed to make an exploratory study of arc units with the intent of recommending a method of operation, maintenance and service.

Screen Brightness

Topics discussed included Theater Screen Luminance for Indoor Theaters; Luminance of White Matte Screens; Screen Luminance for Review Rooms; and Templates for Locating the Screen Areas to Be Measured in Determination of Screen Luminance. On the last subject, majority opinion held that it would be desirable for the Society to make special templates available to aid in the measurement of screen brightness.

Two British Standards on screen luminance, B.S. 2964:1958 and B.S. 2954:1958, were discussed. Additional study may be indicated.

Engineering Vice-President Axel Jensen reported that the Closed-Circuit Television Subcommittee has requested assistance of the Screen Brightness Committee in measuring television screen brightness (particularly in measuring incident light) and with other matters having to do with nomenclature.

Sound

The Staff Engineer reported on the status of five completed projects. Nine 1953 Standards, which had been circulated for review, were discussed.

A lengthy discussion took place on the ISO-SMPTE Replay Characteristic. The history of the problem concerning the unmodified CCIR which has been adopted by the Europeans was reviewed. It was noted that the British have recently circulated a draft Standard which proposes a flat film in accordance with the CCIR characteristic, without the optional deemphasis desired by the United States. It was brought out in discussion that resolution of United States and European differences on frequency characteristics would not be easy. The Committee voted that the Society circulate a film prepared by Westrex in accordance with the unmodified CCIR characteristic for the purpose of study, evaluation and equipment trial.

Other matters reported upon included Multi-Azimuth Test Film; PH22.44, 16mm Multifrequency Test Film; PH22.82, Sound Transmission of Perforated Projection Screens; PH22.40, Photographic Sound Record on 35mm Prints; and PH22.88, Magnetic Coating of 8mm Motion-Picture Film.

Standards

A report on 44 proposals currently in the process of becoming American Standards was presented by the Staff Engineer. The report did not include those still under study or in the preliminary stage of development. The work of the Committee was discussed and suggestions were made for procedures which would expedite the processing of Standards while allowing sufficient time for thorough investigation and discussion of all technical questions.

Television

The extent of the Society's activity in the field of television was discussed at length in relation to definition of the proper limitation of the Committee's interest. In response to an inquiry about whether the jurisdiction of the Society includes the conversion of the optical image to an electrical signal, a number of divergent opinions were expressed. An active liaison policy was proposed. It was also unanimously agreed that members of the Color and of the Television Committees should be appointed to represent the Society in related activities. It was agreed to reconsider this matter at the Fall meeting.

Engineering Vice-President Axel Jensen reported that at the last meeting of the Board of Governors, Howard Chinn had been appointed Chairman of an ad hoc committee to explore the area of magnetic video recording and to make recommendations as to possible activities of the Society in this field. Following presentation of a preliminary report it was generally agreed that the Society should undertake overall guidance of video-tape recording and should request assistance of other groups in order to meet this major responsibility. The need for tape test material was indicated and it is expected that a permanent SMPTE Video Magnetic Recording Committee will be formed.

In a subsequent action, a Video Tape Recording Committee, under the chairmanship of Howard A. Chinn, was constituted by the Society's Board of Governors at their July 11 meeting. The scope of activity of this committee is: "To propose standards and good engineering practices for the construction, adjustment, operation and measurement of video tape recording and reproducing equipment and for those video tape dimensions or other characteristics which affect performance and interchangeability."

ASA Sectional Committee PH22

Brief reports were presented by the United States members of the seven working groups. Main purpose of the meeting was to discuss plans for the meeting of ISO/TC 36 scheduled to be held in Harrogate, England, June 16–20 —*J. Howard Schumacher*, Staff Engineer.

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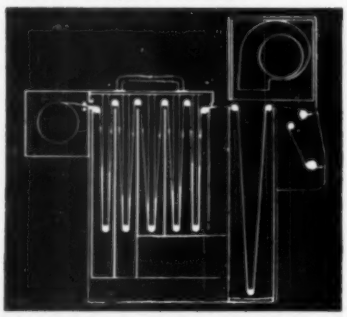

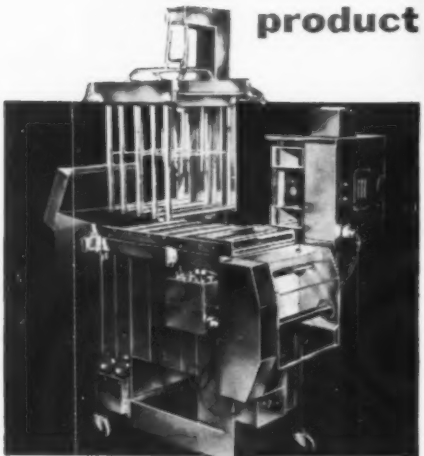

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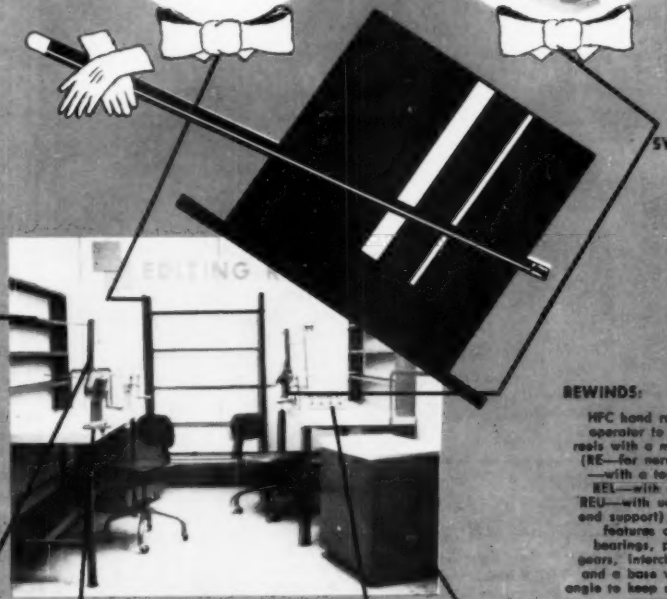

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SWIVEL BASE

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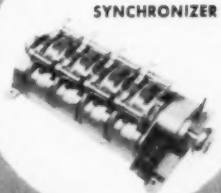
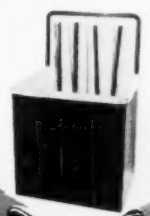


LEADER STANCHION

FILM BIN



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section reports

The Atlanta Section's meeting of Apr. 21, was concerned with a closed-circuit color telecast of various film samples. 42 members and guests were on hand at WSB-TV, Atlanta, when the program started with a 30-min demonstration film, assembled by B. M. Loden and Edward Burris. The reel contained original color as well as color-duped material from the same roll of original. Several black-and-white film types were also included. The film was telecast and monitored on color and black-and-white receivers for the group to view simultaneously.

Henry White of WSB-TV gave recommendations as to the lighting to use for color films for television. After the closed-circuit demonstration, the same reel was projected directly to the group in order that they might note the color losses and cut off differences. At the conclusion of the meeting the television receivers were switched to a network color transmission. Before the meeting the group had the opportunity to tour the facilities of WSB-TV.—*Edward E. Burris*, Secretary-Treasurer, 2693 Winding Lane, North Atlanta 19, Ga.

The Canadian Section held a meeting on Apr. 1 at the National Film Board Auditorium in Montreal. 62 members and guests were rewarded by a particularly stimulating session.

To open the meeting, Norman Oldring, Canadian Broadcasting Corp., acting as chairman introduced Don Dixon of Canadian Kodak Co., Toronto, who presented a new motion picture on film-handling practices entitled "Murder on the Screen." The film was followed by a paper on "A Flexible Interlock Motor Control," written and presented by Norman Bounsall, Chief Technical Officer, Sound Division, National Film Board. The paper described the various interlock methods, and in particular, the system developed by National Film Board to control the operation of a large number of machines in desired combinations by means of pushbutton power switching gear.

After a brief pause for coffee, the meeting resumed with a panel discussion on "Optimum Quality of Sound and Picture for Television," which was related particularly to the use of film. R. S. Rekert, National Film Board, acted as Moderator, with F. J. Quinn, Trans-World Labs, Montreal; Chester Beachell, National Film Board; Gilles Fleury, CBC Montreal, and R. J. Ross, CBC Toronto, as members of the panel. A lively discussion ensued, during which R. J. Ross protested that much of the current footage of televison film would not be accepted by the motion-picture industry for its own purposes. F. J. Quinn claimed that the broadcasters are in part responsible for this in continuing to accept poor material. On the other hand, he complained that the so-called television film standards issued so far are too vague, and are not uniformly applied by broadcasters. Gilles Fleury commented that it would be very difficult for the French language network of CBC to enforce quality because of the limited amount of suitable film that is available. Chester Beachell argued that much of the difficulty is due to the film reproducing systems used by the broadcasters. Mr. Quinn of CBC, a member of the audience, described the response characteristics of vidicon reproducers and explained the necessity for reduced contrast in television film.

A short film produced in Canada and considered to be almost ideal for telecine reproduction was projected on the screen. Barry Gordon, CBC Film Service, a member of the audience, explained that this was a print on du Pont 824 film from a normal motion-picture contrast negative.

There appeared to be general agreement that different types of prints are required for screen projection and television reproduction, but that the same negative could be used to make both prints. The question of 35mm film in television was raised and it was pointed out that the television industry is almost universally committed to the 16mm film size. R. J. Ross raised the problem of the 16mm emulsion position in reply to a complaint by Chester Beachell regarding sound focus on air, claiming that the present 16mm standard is out of date and should be revised in line with

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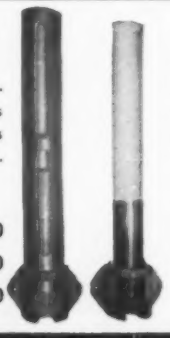

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present requirements. Ivor Lomas, Program Chairman, outlined plans for a joint Montreal-Toronto meeting to be held in Kingston, Ontario, May 24.—*Ronald E. Ringler*, Secretary-Treasurer, Du Pont Co. of Canada, Ltd., Toronto, Ont., Can.

The Dallas-Ft. Worth Section found that it had an overflow crowd of 80 members and guests for its May 6 meeting held at Studio "B," KRLD-TV in Dallas for an explanation and demonstration of the Ampex Videotape Recorder VR-1000 and two papers on an improved professional 16mm color film.

Jack L. Neitliech of Ampex discussed the construction and theory of operation of the Videotape Recorder. A demonstration of the tape equipment was given during a tour of the main control center in the KRLD-TV studios.

Forest Richey and Deane S. Thomas of the Eastman Kodak Co. stopped over on their way back from the Los Angeles convention to read their papers on the Eastman Ektachrome Commercial Film. Because of a program that was of interest to both the film and television people, this was one of the section's best-attended meetings. Late-comers found that it was a "standing room only" show.—*E. J. Pattist*, Secretary-Treasurer, 3618 Marsh Lane Pl., Dallas, Texas.

The New York Section, with members of the Audio Engineering Society as guests, met on Apr. 2 at the RCA Victor Recording Studios in New York City to hear E. A. Dickinson of the Westrex Corp. read a paper by C. C. Davis and J. G. Frayne on "The Westrex StereoDisk System." Because of fire regulations, many had to be turned away at the door, but 391 members and guests managed to squeeze into the two studios provided for the reading of the paper and an actual demonstration of the system which was conducted by W. P. Miltonburg, Radio Corp. of America.

The paper, describing the Westrex StereoDisk cutter which records two stereophonic channels in a single groove with a single stylus, was followed by an interesting discussion period. After the discussion, a social half-hour was enjoyed by the members and their guests, with coffee and cokes served through the courtesy of the RCA Film Sound Recording Division and the RCA Victor Co. At the demonstration after the break, the audience had the opportunity of comparing the quality of the StereoDisk reproduction with that of the original stereo tape from which the disk was dubbed. There was general agreement that little, if any, degradation of quality was noticeable due to the transfer.

Because of the unusually large crowd, the meeting was conducted in two studios, the paper being read in one studio and "piped" to the second studio where a second slide machine was installed. The demonstrations were given over duplicate sound systems in each studio. Preceding the meeting, 22 members and guests attended a "dutch treat" dinner at Al and Dick's Steak House on West 54th St.—*Robert M. Fraser*, Secretary-Treasurer, NBC, Rm 578, 30 Rockefeller Plaza, New York 20, N.Y.

The San Francisco Section met on Apr. 8 at the Pacific Telephone Company's Grant Avenue Building, following dinner at Camille's Restaurant. The high spot of the meeting was an informal talk about the television facilities and operations of the Bell Telephone System, which was delivered by M. W. Walther, Toll Service Supervisor of the Northern California Division of PT&T.

Of particular interest was his description of the problems which faced the company in developing and building, in the short span of eight years, the vast nationwide microwave system in use today. For example, the very narrow microwave beams are subject to deflection under certain conditions of atmospheric stratification in the propagation path. At times, this deflection causes the transmitted signal to miss completely the receiving antenna, resulting in complete loss of signal. Fortunately, this fading is usually frequency selective, so one stand-by channel is used to provide almost complete protection for five regular channels. The switching to and from this protection channel is done automatically before the signal degradation reaches a point where it can be detected by the home viewers.

Following the talk and prior to a tour of the facilities of the Radio and Television Operating Centers, Mr. Walther answered ably all the questions put to him by the members.—*Roger L. Woodruff*, Secretary-Treasurer, KRON-TV, 929 Mission St., San Francisco.

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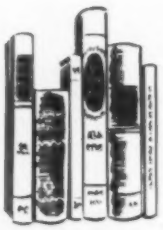

books reviewed

Handbook of Noise Control

Edited by Cyril M. Harris. Published (1957) by McGraw-Hill Book Co., 330 W. 42 St., New York 36. 1005 pp., illus., graphs, tables. 6 by 9-in. Price $12.50.

A relatively new phrase, noise control, has been firmly establishing itself in our acoustical terminology. A journal using this title has been in publication for several years. Now a handbook bearing the same name has appeared in print for the first time.

An impressive list of authors in acoustics and allied fields have contributed their best, under the guiding hand of editor Harris, to a mighty volume embracing 40 different sections of material mainly devoted to the control of noise, defined as unwanted sound.

For many of us, it is generally our practice to consult texts on architectural acoustics whenever a noise problem presents itself. In such references are found the usual tables of absorption coefficients, transmission losses, and similar data necessary to achieve a solution. These items are all here, and more, included under such titles as Acoustical Materials; Control of Solid Borne Noise; Transmission of Noise Through Walls and Floors; Propagation of Sound in the Open Air; and Acoustical Filters and Mufflers.

But apparently this is just a small part of noise control. Some things must be attacked at the source, so we find considerable technical attention paid to topics such as Gear Noise; Bearing Noise; Electric Motor and Generator Noise; Reduction of Noise of Iron-Core Transformers and Chokes; Fan Noise; Heating and Ventilating System Noise; Compressor; Household Refrigerator, and Room Air Conditioner Noise; and Noise in Water and Steam Systems. Examples are often given, however, which are surprisingly nontechnical, and which hit close to home. There is an illuminating discussion on the use of pressure relief stubs near faucets to eliminate water-hammer.

The worst offenders among external noise sources are land vehicles and aircraft. The sound fields accompanying them and measures for reduction are treated at length in sections entitled Automobile Noise (including trucks, buses, and motorcycles); Noise in Rail Transportation; Aircraft Noise Sources; and Aircraft Noise Control. The advent of the jet aircraft has brought us some of the loudest sounds yet to be encountered on or off the ground. Jet nozzle exhaust noises and the frightening sonic boom are simply analyzed in the latter sections in a way as to satisfy the most curious.

Many noises are closely associated with mechanical vibration at some stage or other in their transit to the ear. Sections on Principles of Vibration Control; Vibration Isolation; Vibration Damping; and Vibration Measurement are devoted to this aspect. Emphasis is placed on the intelligent use of the flexible mount. The overall picture, involving both vibration and sound is treated under Systems Considerations in Noise Problems.

It is interesting to note the trend toward octave band measurement of noise as a compromise between detailed spectrum analysis and the single-valued meter reading, with sections on Instruments for Noise Measurement and Noise Measuring Techniques covering all phases in adequate fashion.

The human ear as a sound detector, its limits, frailties and variable characteristics are handled well in a series of chapters: The Hearing Mechanism; The Loudness of Sounds; Audiometry Testing in Industry; Hearing Loss Resulting From Exposure; and Ear Protectors. Of considerable interest are some new computational procedures for estimating the loudness of noise.

The impact of sound and vibration on man is continued in several informative chapters such as, Effects of Noise on Speech; Effects of Vibration on Man; Effects of Noise on Behavior; Community Reaction to Noise; and Community Noise and City Planning.

It seems that man's effort to control noise is rapidly extending outside the technical field as indicated by the number of chapters treating legislation. Legal Aspects of the Aircraft Noise Problem; Legal Liability for the Loss of Hearing; Anti-Noise Ordinances; and Noise Control Requirements in Building Codes show the restraints being imposed on those who would disturb the peace or menace the health of the individual and his community.

Finally (and in line with the popular philosophy of "When all else fails, consult the instructions"), it should be mentioned that the two initial chapters deal with basic concepts and definitions under the titles of Introduction and Terminology; and Physical Properties of Noise and Their Specifications. The reader will no doubt be happy to refer occasionally to these in connection with researches on the more specific sections.

This is a most comprehensive collection of noise data. Although much of it consists of established textbook material, there is a considerable amount which, up to this time, has been presented only in technical papers. There is even a fair portion of previously unpublished work which alone should make this volume a wanted item on the bookshelf of the sound engineer.—*Floyd K. Harvey*, Bell Telephone Laboratories, Murray Hill, N. J.

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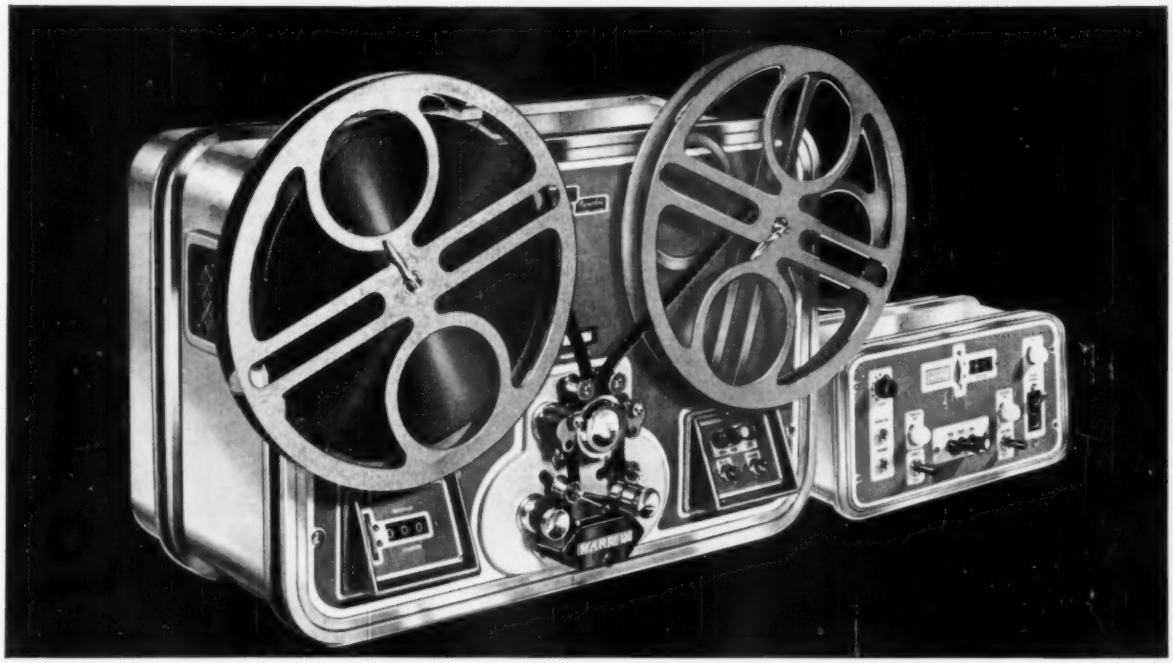

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Proceedings of the National Electronics Conference Vol. 13

Published (1958) by National Electronics Conference, Inc., 84 East Randolph St., Chicago 1. i-xiv + 1066 pp. (incl. numerous charts, diagrams and tables) 6 by 9-in. Price $7.50

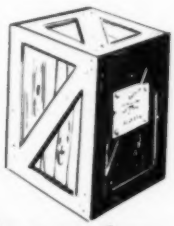
This year's issue of the annual publication follows the pattern made familiar by the previous volumes. Once again the range of subjects is wide, the editing and format excellent and the entire result a proper companion to its predecessors. Of special interest to the readers of this Journal should be the unusually large number of papers directly applicable to Television and Motion Picture Engineering, with eleven papers falling in this category.

Some specific articles which might be singled out are, "Recent Advances in Luminescence" by H. F. Ivey; "Beam Landing Errors and Signal Output Uniformity of Vidicon Tubes" by R. G. Neuhauser and L. D. Miller; "A New Image Orthicon Employing a Multi-Alkali Photocathode for Color Cameras" by P. W. Kaseman; and "Airborne Closed Loop TV System" by A. F. Flacco. Worthy of special note is "Recent Advances in Luminescence" which is an excellent comprehensive survey of this field, and should be of value to both the novice for its general information and to the experienced engineer for its specific data and elaborate bibliography. This type of article retains its usefulness through the years while many limited specialized articles are obsolete before they are printed.

A relatively small percentage of the articles in this volume are of the latter type, which is a commentary on the care with which the papers are selected, and the generally high technical level of the presentation. Of course, as always, the encyclopedic nature of the material causes limited areas to be applicable to any one specialty. However, as noted above, the large number of television and sound oriented articles, in addition to the high percentage of related articles on such topics as transistor circuits and general circuit design and synthesis should make this volume of more than usual interest to the reader of this Journal. A few outstanding examples of the latter type are "Modern Practices in Noise Control" by R. W. Benson; "Transistor Multiple Loop Feedback Amplifier" by F. H. Blecher; "Feedback Amplifier Design by Forward Equivalent Circuits" by L. M. Vallese and "A, B, C, D-Network Design Easy as Pie" by L. Weinberg, with the facetious title of the last belying its value as a general survey and reference article.

Other topics covered which may be mentioned in passing are computers, microwaves, servomechanism and electron tubes, with the list still not complete.

In summary, this volume does not lower the high standards set by previous volumes in the series, and does contain a larger number of articles pertinent to Television and Motion Picture Engineering than has been the case in the past. On this basis, if previous volumes have been found useful, this one should be considerably more valuable and is recommended to the reader.—*S. Sher*, General Precision Laboratory Inc., Pleasantville, N.Y.



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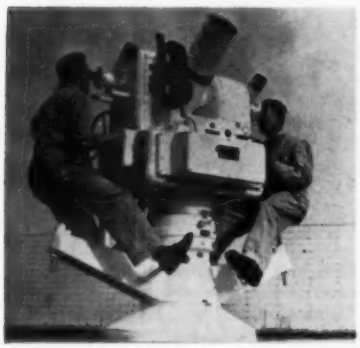
Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.



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"Shockwave Photography of Large Subjects in Daylight," by Harold E. Edgerton, appears in *The Review of Scientific Instruments*, pp. 171–172, Feb. 1958. The direct shadow method, most frequently used in ballistics photography is limited because photographs must be taken in the dark and on film of approximately the same size as the area to be studied. The method described in the article employs a large reflective screen. The object to be photographed travels between the screen and the camera. The screen, called Scotchlite, is covered with small glass beads and has the property of reflecting light from a source back to the source. It is manufactured by Minneapolis Mining and Mfg. Co. One type of screen, Silver Type 244, is used at night, or in the dark; a second type, Black Type 234, is used in daylight.

In photographing a shockwave in daylight, a short exposure of the shutter is essential. The camera shutter can be used to initiate the chain of events. As soon as the shutter is opened, an electrical signal fires the explosion through a firing unit. Early light from the explosion triggers a phototube device and the outgoing signal then triggers an electronic flashlamp located at the camera lens.

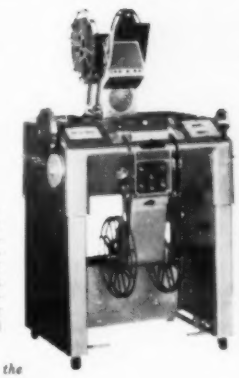
Reprints of the 2-page article are available upon request to Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15, Mass.

A low-noise UHF and microwave amplifier which uses semiconductor diodes as the active elements is now under development at Bell Telephone Laboratories. The amplifier is expected to improve the performance of radio receivers, such as those used in radar, radio astronomy, over-the-horizon radio relay and UHF television systems, by reducing the noise added to incoming signals by presently available amplifiers and converters. This amplifier is one of a family of devices known as variable reactance amplifiers in which a variable reactance (varactor) serves as the active component. In this device the variable reactance is provided by a semiconductor diode (varactor diode) whose capacitance varies with the applied voltage.

The Panavision Brightness Meter is a product of Panavision Inc., 1917 Pontius Ave., Los Angeles 25. Designed primarily for theater use, its primary function is the measurement of brightness as expressed

Today's expanding 16mm production requires precise and dependable equipment such as the new Westrex Recorder-Reproducer and the Academy Award-winning Westrex Editer to match Hollywood standards and to keep costs down.

THE WESTREX 16MM MAGNETIC RECORDER-REPRODUCER (Type RA-1552-G) is easy to control and operate. It records, re-records and reproduces. Fast rewind, minimum maintenance and full 2400-foot reel capacity are only a few of the features that make this equipment so valuable for high-quality 16mm production.



THE WESTREX 16MM EDITER (Type RA-1527) is a versatile editing machine. Every feature to simplify viewing and synchronization is incorporated. Projection-viewing which requires no adjustment of the normal optical system is provided. It was designed in co-operation with leading Hollywood studios. It won an Academy Award for scientific and technical achievement.

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Westrex Corporation

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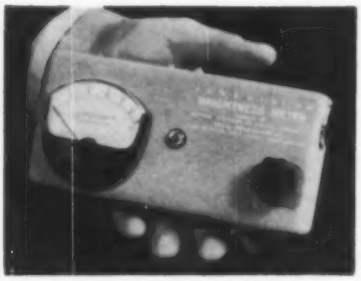
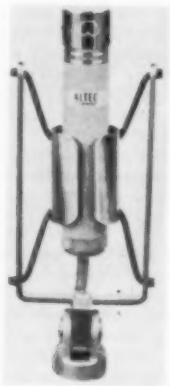


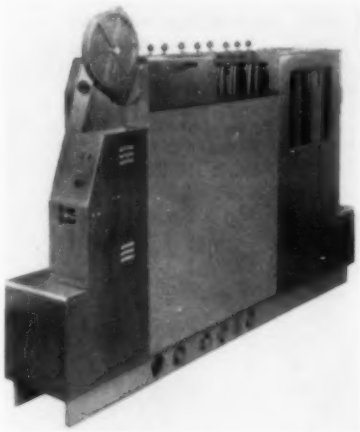
in foot-Lamberts. A plug-in photoelectric attachment permits measurement in foot-candles. The meter is of the visual comparison type and the field is color matched to provide accurate readings even by amateurs. It returns to its last previous reading when the switch is closed. The microammeter is automatically short-circuited when not in use to protect the meter during shipping and from rough handling. It is powered by a single 1½-v standard flashlight battery. The meter is priced at $99.50 and the plug-in attachment for incident light is available at a price of $22.50.

A cardioid condenser microphone weighing 1⅛ oz and measuring ⅞ in. in diameter and ⅞ in. in length has been announced by Altec Lansing Corp., Anaheim, Calif. Called the 29A, it has been designed for high sensitivity and discrimination and the frequency response has been announced as extending flat to 18,000 cycles with a range of 20–20,000 cycles.



Altec's M30 system is comprised of the microphone together with auxiliary equipment. The 175A base contains the impedance matching tube and connects the microphone and power supply. The 169A shock mount with swivel head can be used to eliminate transmission of mechanical vibrations from boom or stand. The new directional system is designed to complement the earlier system which has an omnidirectional microphone. The two microphones have similar operational characteristics. The M30 system is priced at $334.00.

Ott-Lovick High-Efficiency Air Squeegees (*Journal*, pp. 191–194, Nov. 1954) are now available in custom-built models from BHO Instruments Inc., 20 Landing Road South, Rochester 10, N.Y. The squeegees, made to Eastman specifications, are available in stainless-steel models, priced at $375.00 and in chrome-plated brass at $315.00. The company, which specializes in making projection, printing, processing and color measuring instruments not readily adaptable to mass production, offers Blo-Baks, for use with air or water in removing processing solutions and/or partial drying at various parts of the process, at prices ranging from $30.00 for one to $20.00 in orders of five or more.



A new model of the Houston Fearless Labmaster 16mm black-and-white film processor has been announced by Houston Fearless Corp., 11827 W. Olympic Blvd., Los Angeles 64. Of modular design, it can process negative or positive film and, with the addition of an extra unit, can also process reversal film. It is fully automatic, operating up to 40 ft/min. Features include stainless-steel tanks, built-in refrigeration, turbulation pumps on developer tanks, built-in air compressor, and clutch-drive film transport. The negative-positive model is priced at $4,175.

Error: In the June 1958 *Journal*, p. 437, the story about the Houston Fearless Color Labmaster contained the wrong speed. That processing machine for 16mm Eastman Ektachrome 7255 and 16mm and 35mm Anscochrome has a variable speed up to 30 ft/min.

A special type of gas Maser has resulted from a study conducted for the Army Signal Engineering Laboratory by Philco Corp., Philadelphia. Described as an "atomic" amplifier, it demonstrates unilateral gain of microwave energy by means of two electrically isolated cavities connected by a beam of neutral ammonia gas molecules. Energy is transferred from one electromagnetically isolated point to another by the flow of these molecules. As the oscillating molecules pass through the second cavity, electromagnetic radiation is developed and it appears in the output waveguide. The original concept of amplification and oscillation by uncharged molecules through use of a Maser was demonstrated by Columbia University in 1955. Since Masers can provide amplification approaching the theoretical limit of no extraneous noise, this development has potential industrial as well as military applications.

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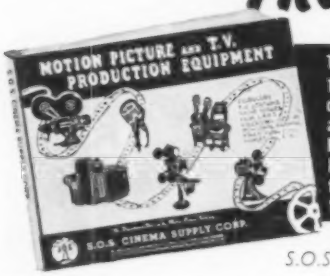

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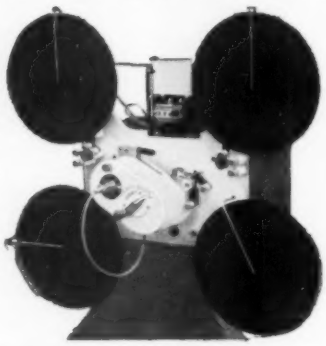

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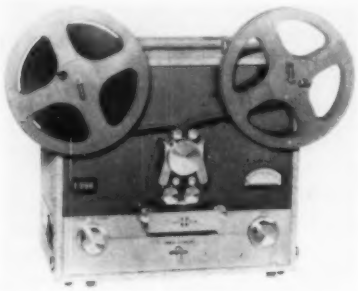
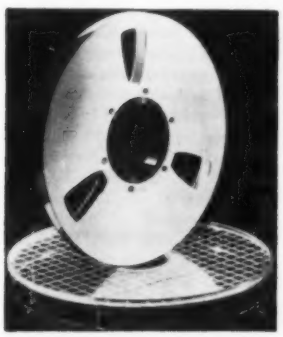
Kodachrome 8mm and 16mm Films and 35mm and 828 film for miniature cameras can now be purchased with "Kodak Prepaid Processing Mailers," permitting sending exposed film to any Kodak laboratory in the United States, Europe, Africa, Asia, Australia, Canada and Mexico. After processing, Kodak will return the film by first-class mail. The service is expected to be especially useful for travelers.

Printing Color Negatives is a recent addition to the Kodak Color Data Book series. Of special interest to still photography, the 56-page booklet describes in detail the technique of printing on Kodak Ektacolor Paper. The booklet is illustrated with 8 pages in color and a 4-page insert on "Simplified Color Printing." It is priced at 75 cents and is available through Kodak dealers.



A portable film recording system, Model 1216, has been announced by Hallen Electronics Co., Div. of Schoen Products Co., 332 North La Brea Ave., Los Angeles 36. Features include encapsulated modular plug-in amplifier sections, 1200-ft capacity, precision nylon gears, the Davis tight-loop filter system and complete transistorization. The system weighs 25 lb and the panel size is slightly over 4½ by 12½ in. The system, for 16mm, is priced at $895; 17½mm, $940; 35mm, $1020; and comoination 17½mm/35mm, $1085. Complete specifications and descriptions of accessories are available.



A precision-made "Scotch" brand reel for magnetic tape used in critical instrumentation recording applications has been announced by Minnesota Mining and Mfg. Co., Dept. A-8-172, 900 Bush St., St. Paul 6, Minn. The reel employs a new tape-threading device which eliminates the threading slot in the hub. Instead a high-friction synthetic rubber ring bonded to

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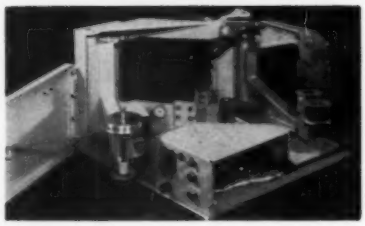
the hub enables the tape to grip the reel after only a single turn by hand. Designed for use in the telemetering field, the new reel has been field tested for use in videotape recording, machine control systems, electronic computers and other critical instrumentation applications. The reel is available in 10½ in. and 14 in. diameters for use with ¼-in., ½-in. and 1-in. instrumentation tape and 2-in. "Scotch" brand video recording tape.



An automatic bulk tape eraser has been announced by Ampex Corp., Redwood City, Calif. Designed for fast, high-volume degaussing on a continuous or intermittent basis, the unit accommodates all types of metal and plastic reels in tape widths up to 1 in. and in diameters of 7 through 14 in. In operation, a reel of tape is placed on a spindle and the door is closed, initiating the automatic degaussing cycle. Moments later a green signal indicates completion of the cycle. Before the green light can appear, the moving parts of the degausser must have completed an uninterrupted cycle. During the operating sequence, a controlled relative motion of both tape and degaussing field produce an optimum erasing pattern, with signal and extraneous noise reduced below fundamental tape noise. The unit is priced at $675.00. Shown is the model for rack mounting and an inside view of it. There is also a table model.

A new line of professional tape recorders has been announced by Presto Recording Corp., a subsidiary of Siegler Corp., P.O. Box 500, Paramus, N.J. Features of the Presto 800 series include a tape edit button to minimize editing time by facilitating easy runoff of unwanted tape; a separate cue button for hand cuing without using motor or brakes; three motors (direct-drive hysteresis synchronous capstan motor and two torque motors); 10½-in. reel capacity, and a newly developed brake to stop tape passage at any speed. The brake drum is made of molded phenolic resin. Specifications are: speeds, 7.5 and 15 in./sec; speed regulator (wow and flutter), no more than 0.10% at 15 in./sec or 0.15% at 7.5 in./sec; signal-to-noise ratio, 60 db at 1.0% distortion; playback amplifier distortion, 1% (harmonic) at +18 dbm output from 35 to 15,000 cycles/sec; frequency response, 30–20,000 cycles/sec ±2 db at 15 in./sec and 40–12,000 cycles/ sec ±2 db at 7.5 in/sec; heads accommodate up to four full or halftrack. Transport panel size is 19 in. by 15¾ in. Preamplifier size is 19 in. by 7¾ in. and separate power supply panel size is 19 by 3½ in. The C800-1 (in CC-10 console) is priced at $1649.00. The C800-3 (in CC-11 console) is priced at $2094.00.

An 8-page illustrated catalog describing synchronous ¼-in. magnetic recording equipment is available without charge from Rangertone Inc., 73 Winthrop St., Newark N.J. The catalog also contains a description of the company's Sync Kit which can be installed on most tape recorders for recording lip sync sound for motion pictures.

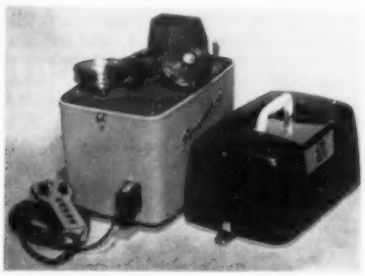
Color video-tape recordings of surgery were demonstrated as a new visual education aid before the recent American Medical Association Convention at San Francisco. Three operations were seen, first on closed-circuit color TV and later on a video-tape recording. The operations took place in San Francisco Hospital and were broadcast in color to the Civil Auditorium. At the same time an Ampex Videotape Recorder in Ward A of the hospital recorded magnetically everything the color TV camera caught. The Ampex color converter accessory was used with the VR-1000 for the color recording. The TV and video tape showings were presented cooperatively by Ampex Corp., Redwood City, Calif., and Smith, Kline and French Laboratories, Philadelphia, Pa.

The company also announced delivery of a VR-1000 recorder to Station WGBH-TV Boston — the first such installation in a noncommercial, educational station. Another announcement disclosed plans for installation of service and parts depots at various localities throughout the United States as a function of its Professional Products Div. The depots will carry stocks of parts for emergency repairs and will maintain a staff to service professional equipment. The first of the depots has been opened at 345 E. 48 St., New York. Joe E. Blanks has been appointed Service Engineer for the New York District.

The *Story of Magnetic Recording* is a history of the development of tape recording from "a little known laboratory oddity to a multimillion dollar industry," prepared by Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn. The his-

tory traces the development of magnetic recording from Poulsen's wire recorder, of about 1900, through World War II and into the present era, with special emphasis on the important progress made in the late 1940's. The history was presented to the Department of Audio Visual Instruction of the National Education Assn. during its National Meeting held in Minneapolis during April 1958. A limited number of copies are available from the company upon request.

A 300-w lamp which supplements the company's R-30 375-w lamp for black-and-white motion-picture and still photography has been announced by Sylvania Electric Products Inc., 1740 Broadway, New York 19. The new lamp is 4¾ in. in length. It is priced at $1.35.



The PerceptoScope is a variable-speed 16mm projector manufactured by Perceptual Development Laboratories, 6767 Southwest Ave., St. Louis 17. Designed for audio-visual use, it is especially applicable for training programs and motion analysis. It can be used for motion-picture, slide or strip film projection or for tachistoscopic projection. It is also capable of projecting simultaneously two superimposed films, the second film superimposing images or control patterns on the first film. The second film can be cued to act as the "electronic brain" to control the advance of the front film. All functions of the projector can be controlled from a hand-sized, electronic remote-control unit on a 25-ft cord. Dimensions are 16½ by 14⅜ by 9½ in., and it weighs 40 lb.

Standard programs of films, books and aids have been prepared for such subjects as reading, typing, office machine operation, industrial engineering, clerical skills and supervisor development.

LaVezzi Machine Works, 4635 West Lake St., Chicago 44, has announced Catalog L-50 which lists and describes the company's 35mm projector parts. The company is currently celebrating the 50th anniversary of its founding and the 46-page catalog is described as a "special issue." Among products listed and illustrated are: BB-66-type intermittent movements; intermittent movement repair kits; E-78-L removable film trap door assembly; RK-107 intermediate and main drive gears; magoptical conversion kits and aperture plates. The catalog also lists parts for various types of projectors and tools for projection repair. A price list is included. The catalog is available to interested persons without charge from the company.

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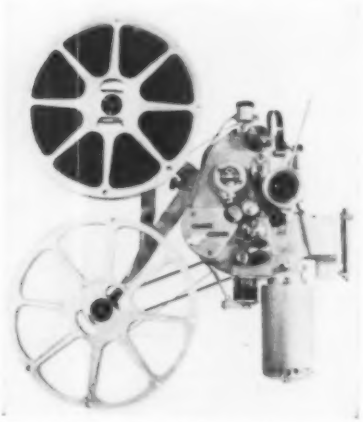


The Debrie 16 auxiliary projector is a supplementary fitting to a 35mm projector which permits the screening of 16mm films without the use of an additional base. When in use the device is attached to a stand which is mounted on an angle-iron fixed to the 35mm projector in such a way that the optical axis of the auxiliary projector coincides with that of the 35mm projector. Before being attached it is threaded with a 16mm film. Before operation, the lens of the 35mm projector is replaced by an optical condenser of the same diameter which enables the use of all the light of the 35mm projection aperture on the 16mm aperture. The 16mm projections are made by starting the 35mm projector (without film) which drives the 16mm auxiliary projector in synchronism. The auxiliary contains its own motor. When the 16mm projection is finished, the auxiliary projector is lifted from its utilization stand and placed on a wall stand where the preliminary threading takes place. Additional information and specifications of this equipment which was exhibited at the Society's recent Convention at Los Angeles are available from Andre Debrie Mfg. Co., College Point 56, L.I., N.Y.

Bulletin No. 4 in the National Projector Carbons series is Part II of an article on "Screen Light Checking Procedure," describing procedures for checking the optical system. Subjects of previous bulletins are: (1) "The Carbon Arc"; (2) "Terms — Light Sources and Screen Illumination"; (3) "Screen Light Checking Procedures Part I." The bulletins, issued quarterly, are available, without charge, to projectionists from National Carbon Co., a Div. of Union Carbide and Carbon Corp., Advertising Dept., 30-20 Thomson Ave., Long Island City 1, N.Y.

An electronic enlarger which features automatic dodging and exposure control for black-and-white enlargements for negatives 35mm to 4 in. by 5 in. is a product of LogEtronics Inc., P.O. Box 2098 Potomac Station, Alexandria, Va. The motor-driven projection head contains a cathode-ray tube scanning light source and phototube for automatic dodging. It is applicable to still photography especially in publicity and other commercial and industrial fields.

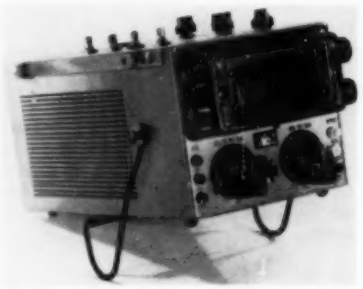
Use of the RCA TK-15 vidicon TV camera as the nucleus of an economical and versatile system is described in a brochure issued by the Broadcast and Television Dept., Radio Corp. of America, Camden, N. J. A TV system can be started with one TK-15 camera and gradually expanded by adding slide and film accessories, a second TK-15 camera and an RCA TK-21 film camera.

GPL Precision Television System, Model PD-250, is a new 4-page catalog issued by General Precision Laboratory Inc., 63 Bedford Rd., Pleasantville, N.Y. The equipment is for closed-circuit or studio use. The viewfinder camera, camera control unit, control console and accessories are illustrated and described.

A low-priced closed-circuit TV system packaged especially for educational use has been announced by Allen B. Du Mont Laboratories Inc., 750 Bloomfield Ave., Clifton, N.J. Priced at $7000, the two-camera system employs a minimum of electronic equipment. The system is portable, which makes it possible to use classrooms as originating points, rather than a special studio. Use of standard television receivers at viewing points rather than more expensive video monitors is recommended. Switching and control panels weigh less than 15 lb.

The RCA Catalog of Broadcast Film Equipment for Monochrome and Color Television, 3d ed., contains information on film equipment designed especially for television and closed-circuit use. There are illustrations and descriptions of cameras, projectors, slide projectors, multiplexers, lens equipment and film accessories. A current price list is included. The catalog is priced at $1.00 and is available from RCA Broadcast Representatives in regional offices throughout the United States or from Radio Corp. of America, Industrial Electronic Products, Broadcast and Television Dept., Camden 2, N.J.

Commercial production of a new transistorized synchronizing generator for television stations has been announced by General Electric, Technical Products Dept., Electronics Park, Syracuse N.Y., after more than two years of experimental work. The new generator is said to be the first to incorporate transistors, printed wiring boards and computor circuitry. Eight printed wiring boards and 80 transistors are used. Dimensions are 14 in. high, 19 in. wide, and 9 in. deep with a weight of about 40 lb. It operates on 135 w. It is expected to be priced at about $3000.



A portable oscilloscope, weighing less than 8 lb, called the Direct Reading Pocketscope Hi-Gain Model S-17-A, has been announced by Waterman Products Co., 2445 Emerald St., Philadelphia 25. Features include dual-dial control, direct reading with scales calibrated in volts and milliseconds, and auto-synchronization. A sync signal in excess of 1-v peak automatically triggers the mechanism and a light indicates the presence or absence of the proper level. Tentative specifications include: signal, sensitivity from 10 mv peak to peak/division, and bandwidth d-c to 250 kc or 3 c to 250 kc; time base — per division, 1 sec to 10 μsec, total sweep, 10 sec to 100 μsec, sync, internal ±, external +, and line +; horizontal — sensitivity, from 400 mv peak to peak/division, and bandwidth, 3 c to 80 kc; power requirements — 40 w, 105–125 v, 50 to 400 c. The oscilloscope case is 4¾ in. in height, 5¼ in. in width, with a depth of 10 in.

Resistance Decade Boxes, Catalog 20D, is available from G. M. Smith, Sales-Service Manager, Cinema Engineering, Div. Aerovox Corp., 1100 Chestnut St., Burbank, Calif. The 8-page catalog is illustrated and describes decade boxes of two basic designs, offering both horizontal and vertical panel arrangements. Units from 2 to 5 dials and accuracies ranging from 0.05% to 1%, with totally shielded circuitry, are listed.

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Cameraman-Director-Editor. College background in all phases 16mm production; 2 yrs experience with college film production units. Desires position with commercial or industrial film producer. Will travel or relocate. Single, age 27. Have films, clips, will send resume. Write: E. B. Fleischer, 217 Hillside Ave., Cranford, N. J.

Rhodesian Producer-Cameraman visiting the U. S. October/November to examine latest motion-picture techniques, processes and equipment, offers knowledge gained during 20 yrs experience all branches film making in primitive Africa to interested organisations. Please write air mail to Geoffrey Mangin, Central African Film Unit, P. O. Box 1184, Salisbury, Rhodesia, Africa.

Ambitious Photographer, twelve years experience, stills and motion pictures. Three years Audio-Visual Department, San Diego City Schools. Two years news photographer, editor and writer for NBC affiliate television station. Presently employed by small production unit shooting TV commercials, news features, and industrial films. Desires opportunity to do creative quality work with future in production organization, television station or industrial firm. Resume upon request. David Bash, Apt. 2, 2826 Mission Blvd., San Diego 8, Calif.

Motion-Picture and TV Equipment. Presently employed with leading firm supplying equipment and technical service throughout the world; thoroughly familiar with all types of equipment and manufacturers; background as free-lance cameraman. Desire position with active organization supplying equipment or sales representative for manufacturer desiring east coast branch. Available mid-August. Barry Green, 1672 Ocean Pkwy., Brooklyn 23, N. Y. Tel: DEwey 6-2454 after 8 p.m. Mon-Tue-Wed.

Motion-Picture Production. Graduate Brooks Institute, MP course, thoroughly experienced in all phases of camera work, editing, optical and magnetic sound recording, and still photography. Produced industrial and educational films, TV commercials. Familiar with B&W processors. Seeking permanent position or temporary assignments. Free to travel, speak several languages. J. C. Klopping, 312 W. Yanonali St., Santa Barbara, Calif. Tel. WOodland 6-1482.

Cameraman-Editor. Would like to join young progressive film-making organization, foreign expedition or exploration party. Recently discharged from Pictorial Branch, U. S. Army Signal Corps. Experienced in sound recording, laboratory and other phases of the motion-picture field. Age 22, single, free to travel. References and complete resume on request. H. LeRoy Mills, 427 Cherry Ridge, San Antonio, Texas. Tel: DIamond 4-6583.

Studio Engineer. Young man (22), vet., graduate of Studio Training Course—TV Workshop, top scholastic man in class; thoroughly qualified audio engineer, TV cameraman, floor manager, video operator, with knowledge of scenery, special effects, lighting, color TV principles and operations; FCC phone license. Willing relocate anywhere; complete resume on request. Martin Morris, 771 West End Ave., New York 25. Tel: MOnument 6-4962.

Positions Available

Industrial Film Writers, Cameramen, Editors. Experienced industrial writer-directors, cameramen, and editors are needed for film production on aircraft and advanced projects at San Diego, Calif. Writers should have college degree and 3 to 5 yrs experience in industrial film production. Cameramen should be experienced with standard 35mm and 16mm production techniques, including sync-sound and set lighting. Editors should be experienced with all lab and editing techniques, including ability to direct dubbing sessions. Applicants should list all personal data, including past experience, employers, and salary requirements. Salary commensurate with experience and ability. Contact R. M. Hall, Motion Picture Section, Building 19, Convair, A Division of General Dynamics Corporation, San Diego, California.

Aircraft Motion-Picture Supervisor. To supervise complete in-plant production of engineering and technical films, including script preparation, directing, cinematography, sound, editing, animation and printing operations. Experience preferred in producing films related to aircraft and/or missiles programs, primarily to meet contract requirements under Air Force Table 210. Must be highly creative and imaginative in conception and execution of films in this field. Personable, tactful individual required, capable of dealing effectively with people at all levels. Write qualifications and experience to: E. Stanton Brown, Engineering Administrative General Supervisor; Convair, A Division of General Dynamics Corp., Fort Worth, Texas.

Sales and Applications Engineers, for photographic instrumentation firm selling airborne and ground data-recording equipment. Experience in aircraft and missile test instrumentation field, with optical and electronic background most desirable. Some travel required western U. S. Please address initial inquiry with brief outline of background to: Mark Macintosh, V. P., Traid Corp., 17136 Ventura Blvd., Encino, Calif.

Theatre Sound Engineer. Must have good technical background and be experienced in theatre sound work. We are expanding. Applications will be treated with strictest of confidence. North West Sound Service, Inc., 73 Glenwood Ave., Minneapolis 3, Minn.

Laboratory Quality Control. Requires thorough experience in sensitometric control methods for B&W and color raw stock (print, sound recording and camera) and developing processes. Knowledge of chemical test procedures for processing formulae and operation of temperature control systems. Ability to judge picture and sound quality. Position will be as assistant to Manager in a rapidly expanding laboratory. Send complete resume of professional background, education and salary requirements to: Dana C. Rogers, Southwest Film Laboratory, Inc., 3024 Ft. Worth Avenue, Dallas 11, Texas.

Senior Electrical Engineer (Arc and Plasma Specialist). Requires background of theoretical and experimental work in the field of high intensity electric arcs and plasma research. Development of practical devices based on arc and plasma technology in a wide range of power. Position offers an opportunity to perform research and development in association with distinguished research personnel; excellent salary and opportunity for professional growth. Laboratory located in Orange County, Calif., 10 miles from Pacific Ocean, 40 miles from downtown Los Angeles. Send resume to Giannini Plasmadyne Corp., P.O. Box 1199, Santa Ana, Calif.

Optics Engineer. Chief of section engaged in photographic and optical support of military video reconnaissance program. Knowledge of photographic sensitometry, processing techniques and geometric optics essential. Reconnaissance systems background and mechanical design experience on aerial cameras or motion-picture apparatus desired. Location—Stamford, Conn. Write: CBS Laboratories, 485 Madison Ave., New York 22. Att: H. P. Munday.

Cameraman. Duties primarily as 16mm cameraman with some work in sound and editing. College production unit engaged in producing 16mm sound and color films of an educational nature. Entrance salary $4704 per year. Send resume of background, experience and references to Norman E. C. Naill, Production Supervisor, V.P.I. Motion Picture Unit, War Memorial Hall, Blacksburg, Virginia.

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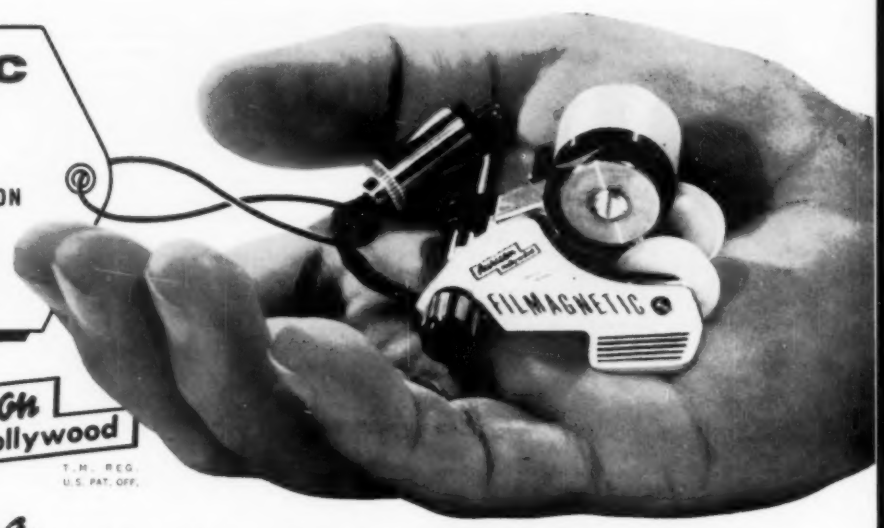

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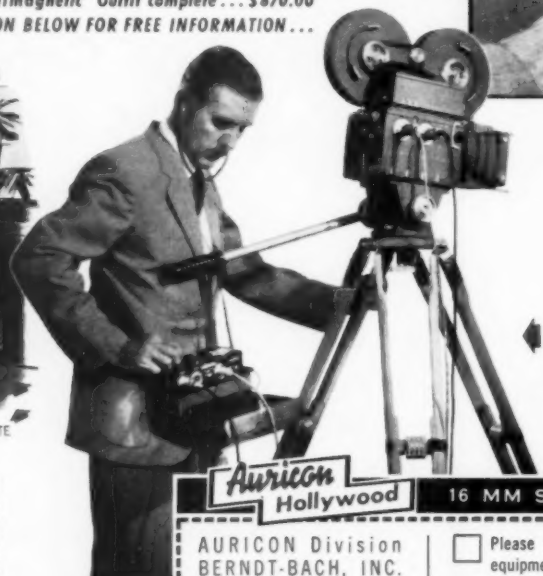

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Meeting Calendar

American Chemical Society, National Meeting, Sept. 7–12, Chicago.
International Scientific Film Association, 12th International Congress, Sept. 10–12, Moscow, U.S.S.R.
American Rocket Society, Fall Meeting, Sept. 14–18, Statler Hotel, Detroit, Mich.
Instrument-Automation Conference, Sept. 15–19, Convention Hall, Philadelphia.
National Symposium on Telemetering, Sept. 22–24, Americana Hotel, Miami Beach, Fla.
Standards Engineers Society, Sept. 22–24, Benj. Franklin Hotel, Philadelphia.
Fourth International Congress on High-Speed Photography, including Equipment Exhibit, Sept. 22–27, Cologne.
10th International Cinematography Engineering Congress, Oct. 2–4, Turin, Italy.
Society of Photographic Scientists and Engineers, Annual Technical Conference, Oct. 6–10, Manger Rochester Hotel, Rochester, N. Y.
Optical Society of America, Oct. 9–11, Hotel Statler, Detroit, Mich.
U. S. National Committee of the International Commission on Illumination (C.I.E.) Annual Meeting, Oct. 13–14, Lion Inn, State College, Pa.
National Electronics Conference, Oct. 13–15, Hotel Sherman, Chicago.
IRE Canadian Convention, Oct. 15–17, Exhibition Park, Toronto, Canada.
84th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 20–24, Sheraton-Cadillac, Detroit.
National Society of Professional Engineers, Fall Meeting, Oct. 23–25, St. Francis Hotel, San Francisco.
AIEF, Fall General Meeting, Oct. 26–31, Penn-Sheraton Hotel, Pittsburgh, Pa.
American Standards Association, Ninth National Conference on Standards, Nov. 18–20, Hotel Roosevelt, New York.
Acoustical Society of America, Nov. 21–23, Chicago, Ill.
American Physical Society, Nov. 28–29, U. of Chicago & Hotel Windermere, Chicago.
Electronic Industries Association, Conference on Reliaole Electrical Connections, Dec. 2–4, Statler-Hilton Hotel, Dallas, Texas.
85th Semiannual Convention of the SMPTE, including Internationa Equipment Exhibit, May 4–8, 1959, Fontainebleau, Miami Beach
86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 5–9, 1959, Statler, New York.
87th Semiannual Convention of the SMPTE, May 1–7, 1950, Ambassador Hotel, Los Angeles.
88th Semiannual Convention of the SMPTE, Fall, 1960, Shoreham Hotel, Washington, D. C.
89th Semiannual Convention of the SMPTE, Spring, 1961, Royal York, Toronto.
90th Semiannual Convention of the SMPTE, Oct. 15–20, 1961, Statler, New York.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Issues beginning in 1953 available on a nominal basis. Write: Mitchell M. Badler, 1711 Davidson Ave., Bronx 53, N.Y.

Complete set of Transactions, except Nos. 6 and 9, and all Journals published to date, including indexes. All in good condition. Price $500. W. W. Hennessy, RFD #2, Pound Ridge, N. Y.

Complete set of Journals from May 1937 to June 1954, including special volumes and membership directories, excellent condition; also Mar., May 1934 and July 1935 issues. Write: Harry R. Lubcke, 2443 Creston Way, Hollywood 28, Calif. HO 9-3266.

Jan.–Dec. 1950; Jan., Feb., Apr.–Dec. 1951; Jan.–Mar. 1952. Also available are vols. 6 and 7 of The Television Society (British) covering the period Jan. 1950 through Sept. 1955. Write: Andrew N. McClellan, 65 Hillside Drive, Toronto 6, Ont., Canada.

Dec. 1946, Feb.–Dec. 1947, 1948-1955 complete. All copies in perfect condition; for sale as entire lot only. Write: Joseph W. MacDonald, 2414 Sullivant Ave., Columbus 4, Ohio.

Jan. 1947 to Dec. 1957 complete and in perfect condition. For sale only as a set. Write: Charles J. Marshall, 2816 Royalston Ave., Kettering 19, Ohio.

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Jan. 1938. E. Raymond Arn. Film Associates, Inc., 4600 S. Dixie Ave., Dayton 9, Ohio

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High-Speed Photography, Vols. 1, 2 & 3. John H. Waddell, Fairchild Camera & Instrument Co., 5 Aerial Way, Syosset, N. Y.

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  Columbia Pictures Corporation
  Loew's Inc.
  Paramount Pictures Corporation
  RKO Radio Pictures, Inc.
  Twentieth Century-Fox Film Corp.
  United Artists Corporation
  Universal Pictures Company, Inc.
  Warner Bros. Pictures, Inc.
Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
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Reeves Sound Studios, Inc.
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Southwest Film Laboratory, Inc.
Technicolor Corporation
Titra Film Laboratories, Inc.
Trans-Canada Films Ltd.
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Wollensak Optical Company